DECEMBER 22, 1958

Price 50 cents

DESIGN issue

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN RESEARCH AND DEVELOPMENT

Farval spray lubrication system keeps A-C ball mill running smoothly

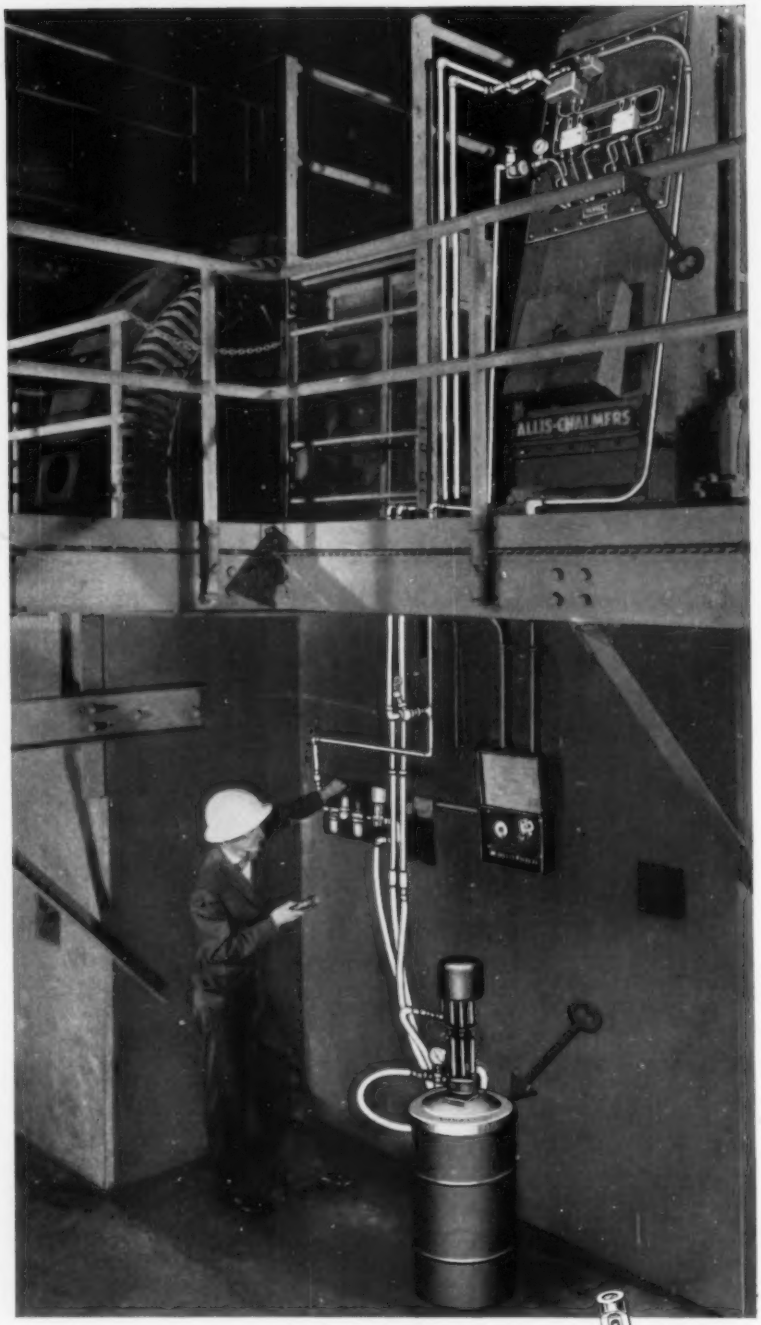
Inspecting the new installation of a Farval spray lubrication system on an Allis-Chalmers ball mill at Marquette Cement Company's Milwaukee plant is Erv Klovers, project engineer at Allis-Chalmers.

Mr. Klovers' task was to find an economical and dependable lubrication system to guard the large diameter, wide-faced gears that power the ball mill. So he contacted Farval and together we designed the original spray lubrication system for ball mill gearing. It was completely flexible in arrangement and position—fit his requirements to the letter—showed savings in both lubricant and labor costs.

With Farval, gears can be sprayed with the proper lubricant in any amount specified, as often as necessary—without waste or mess.

Hooked up to existing compressed air sources, Farval Spray Valves deliver the lubricant to tooth surfaces through controlled air delivery. Large porting in Farval Dualine valves ensure correct lubricant supply with minimum pressure-drop and very minimum grease separation.

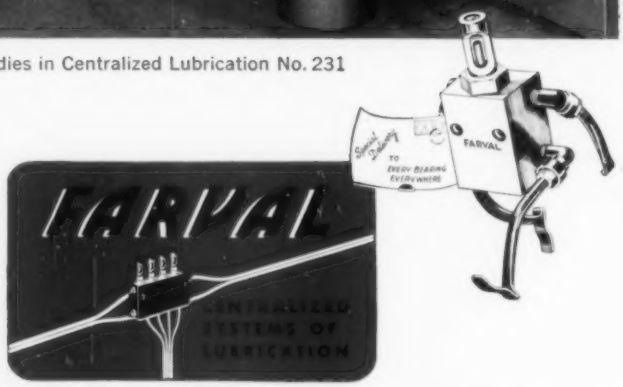
This simple, inexpensive but thorough lubrication system can help you cut maintenance costs as it has for hundreds of others across the nation. See what a Farval system can do for you by asking for Bulletin 26-S. Write The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.



FARVAL—Studies in Centralized Lubrication No. 231

KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval —familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated.



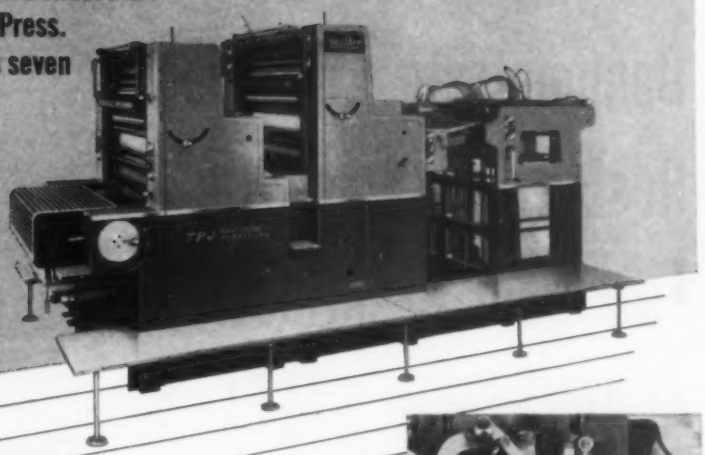
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

Misalignment is compensated for *Automatically*

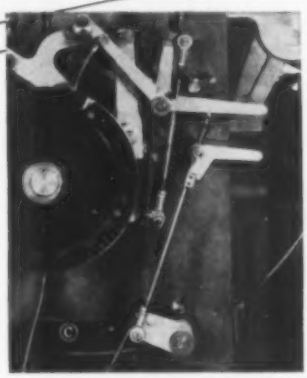
The Miller Printing Machinery Co. has introduced the Miller TPJ Two Color-Perfector Offset Press. In the design of this press, Miller uses seven

HEIM *Unibal*®

SPHERICAL BEARING ROD ENDS

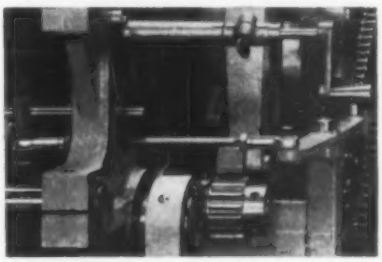


The TPJ is a sheet-fed offset press which converts from printing two colors on one side of the sheet to one color on both sides of the sheet. It can be switched from one to the other in a matter of minutes. It operates at high speeds and prints sheets up to 23" x 36".



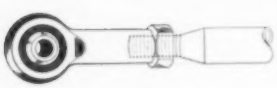
Major section of the first unit trip linkage, where Unibal Rod Ends were chosen to compensate for any slight misalignment, and because they are less expensive than special connections for this application.

These were chosen for several reasons, the principal one being that dimensional and squareness tolerances do not have to be held as close when using the Unibal, as any misalignment is compensated for automatically. The Heim Unibal has a single ball rotating in bronze raceways housed in an outer member or cartridge. The single ball has universal motion to correct misalignment . . . the larger surface supporting area offers greater load ratings for substantially smaller dimensions . . . assembly is simple and fast . . . there is a wide choice of sizes in both male and female types.



Portions of the side guide operating mechanism showing the use of Unibal Rod Ends to connect a walking motion operated by a face cam to a transverse motion.

Heim bearings are sold through the country's leading bearing distributors. Write for complete catalog and/or engineering help.



THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

SPECIFY HEIM UNIBAL SPHERICAL BEARINGS AND ROD ENDS FOR ALL PUSH-PULL AND LINKAGE APPLICATIONS AND WHERE MISALIGNMENT MUST BE COMPENSATED FOR

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These king-sized ducts made of Armco's special hot-dip aluminum-coated steel demonstrate its advantages wherever corrosion resistance must be combined with strength at low cost.

Based on previous experience with ALUMINIZED STEEL, here's why Detroit Edison engineers specified this two-in-one metal:

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- reduces heat loss because of its heat reflectivity
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- reduces maintenance expense
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Wherever you need a sheet steel for outdoor service, ALUMINIZED STEEL Type 2 can give your products sales advantages at a cost that can put you a step ahead of your competitors. Manufacturers of farm equipment, building products, truck bodies, roofing and a wide range of industrial and consumer products are using the material effectively.

For complete information on Armco ALUMINIZED STEEL Type 2 and its companion grade, ALUMINIZED STEEL Type 1, (used for resistance to a combination of heat and corrosion), just fill out and mail the coupon.

ALUMINIZED STEEL air ducts in Detroit Edison's huge River Rouge Power Plant provide superior performance at low cost.

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

DECEMBER 22, 1958 Vol. 29, No. 52

New Standards for Gears * 46... L D Martin, gear consultant
First publication of this expert's answer to the need for an all-inclusive standard covering spur and helical gears—all the way from low-cost commercial to ultra-precise. Author establishes 15 classes for quick usefulness.

Aluminum Gives Strong Stainless 50... J L Ham and R E Cairns Jr, National Research Corp
Progress report on a Navy-sponsored research project to find a lightweight "poor man's" stainless steel. This austenitic candidate contains manganese for high-temperature strength.

Design Features in New Products 52... Coiling the cooler saves water; packaged punch for presses; gears provide knuckle power for front-wheel drive.

Vacuum-formed Plastics 56... R L Daggett, University of Wisconsin
The technique now includes such variations as air-stretching and match-plate forming. It can make deeper parts, more complex designs. Here's the latest on what the process will do.

A HOW-TO

Sound-testing at 150 Db 58... M T Anderson, Avco
Pentagonal sound chamber and special speakers simulate the destructive noise level found in rocket-powered missiles.

Before Selecting a Fhp Motor 60... N L Morgan, General Electric Co
Don't overlook importance of the mechanical features. Here's a guide to basic enclosures, mounting arrangements, bearing types, insulation, as well as those "extras."

DESIGN FILE

20 Simple Locking Devices 66... Federico Strasser, Mankowitz & Strasser Ltd
Latches, eccentric cams, springs that hold two parts together.

More on Swivel Joints 69... G M Bagnard, Chiksan Co
In this last of his three articles, the author supplies charts for finding torque and pressure loss.

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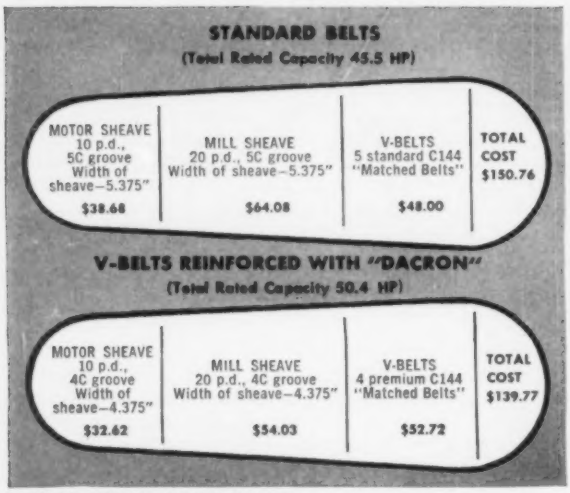
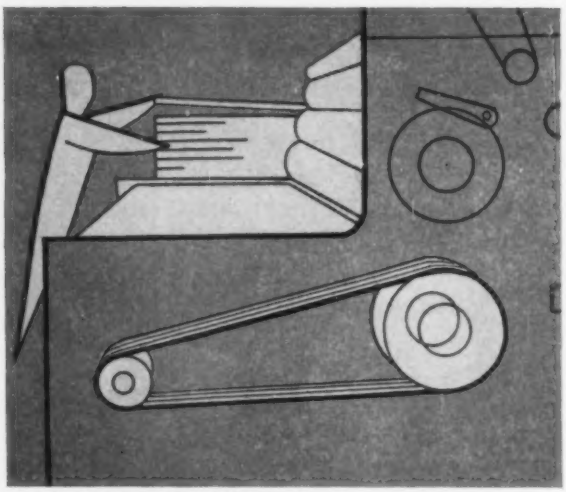
You can make significant cost savings with premium V-belts reinforced with DACRON

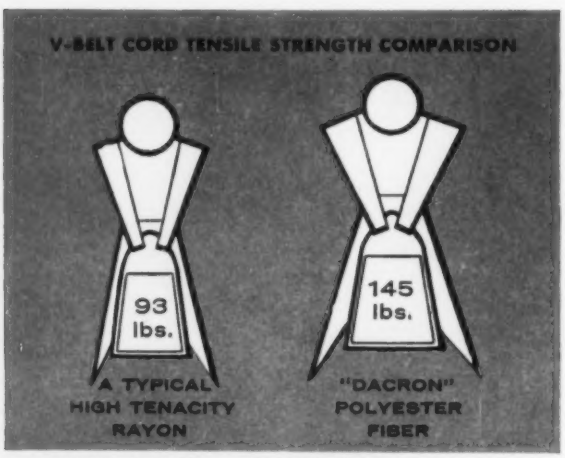
REG. U. S. PAT. OFF.


STANDARD BELTS
(Total Rated Capacity 45.5 HP)
MOTOR SHEAVE 10 p.d., 5C groove Width of sheave—5.375" $38.68
MILL SHEAVE 20 p.d., 5C groove Width of sheave—5.375" $64.08
V-BELTS 5 standard C144 "Matched Belts" $48.00
TOTAL COST $150.76
V-BELTS REINFORCED WITH "DACRON"
(Total Rated Capacity 50.4 HP)
MOTOR SHEAVE 10 p.d., 4C groove Width of sheave—4.375" $32.62
MILL SHEAVE 20 p.d., 4C groove Width of sheave—4.375" $54.03
V-BELTS 4 premium C144 "Matched Belts" $52.72
TOTAL COST $139.77

LOWER INITIAL DRIVE COST. Right from the start, premium V-belts reinforced with Du Pont "Dacron"* polyester fiber save you money! These belts offer greater horsepower capacity, a more compact drive that's easier to maintain.



"LASTED 52 TIMES LONGER than regular V-belts," reports a user of premium belts made with "Dacron". The rugged wearability of "Dacron" fiber extends belt life . . . permits continuous use without costly take-up for belt adjustment.



LESS MAINTENANCE, REDUCED INVENTORY. Even when compared with tough fibers of a high tenacity rayon V-belt cord, "Dacron" proves far stronger. In belts, this means less stretch, minimized matching problems and lowered inventory.

Premium V-belts reinforced with "Dacron" are ideal for high-impact or shock-load drives, yet last far longer than ordinary belts. In a typical installation, 5 premium belts reinforced with "Dacron" did the work of 7 conventional belts. Important economies resulted, too—through longer belt life and by reduction of the number of belts and sheaves.

In standard V-belts, too, the stability of "Dacron" practically eliminates matching problems . . . permits smaller belt inventories.

Check the cost-saving advantages of premium or standard V-belts reinforced with "Dacron" for the next drive you design or install. Du Pont makes the "Dacron" used by belt manufacturers in producing their finest-quality belts. E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Department, Wilmington 98, Delaware.

""Dacron" is Du Pont's registered trademark for its polyester fiber.*

DU PONT
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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

V-BELTS REINFORCED WITH "DACRON" transmit more horsepower . . . stand greater shock loads . . . give longer flex life . . . give greater opportunities for machine-design improvement.

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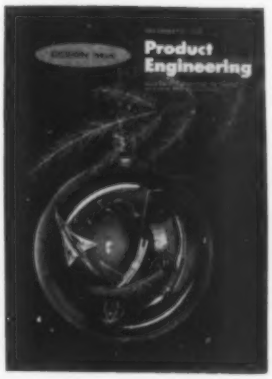
Interesting to Note . . .

Merry Christmas



With thoughts of missiles, rockets and sugar plum Martians dancing through the heads of youngsters, the meaning of Christmas is slowly being forgotten. On our cover however, art director Richard Rooman has tried to capture the traditional Christmas tree ornament reflecting the present while leaving the door to tomorrow ajar.

We have long had the symbolic ornaments and fir trees. Celebrating Christmas with light is one of our oldest holiday traditions. However, the Christmas lights that were once wax candles and are now electric bulbs, soon will have their current supplied by atomic generators.

Though it was the early Christian churches that first blazed with Christmas candlelight, Martin Luther added the candle to a tree and a custom began. An old French legend tells us that a small flame by the Christ Child's manger was kept aglow by a robin flapping its wings. The light led shepherds while the glowing heat kept the Child warm—and the robin's breast remained red forever.

Some Yuletide traditions had strong opposition. When Oliver Cromwell and his Puritan followers came to power in 1644, they looked askance at the gay and noisy celebration that had become a Christian custom. They were particularly incensed over the Yule log. A huge tree, chopped down with much merrymaking and burned throughout the holiday, had been the focus of seasonal revelry since the pagan sun-worshipping rites of ancient Britain, which had also taken place in late December. That was enough for Oliver—he banned Christmas as "immoral sun-worship."

Follow the Painted Poles

More than 1000 manhours go into the detailed drawings of each roadmap now in the glove compartment of your car. Somewhere on each map is a mistake. It may be a misnamed street or perhaps a backwoods road will meander to the left instead of the right. These do not reflect carelessness but are committed intentionally to trap any competitive mapmaker who finds it easier to copy an existing map rather than undertake his own plotting methods. Once a cartographer gave his own name, spelled backwards, to an inconspicuous, unlabeled lake as a means of iden-

(Continued on page 7)

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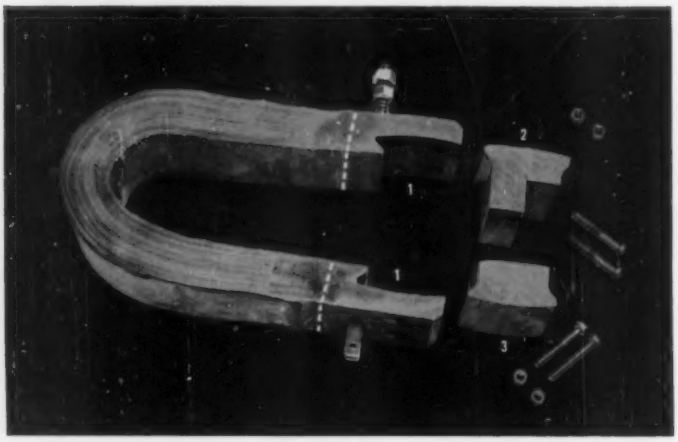
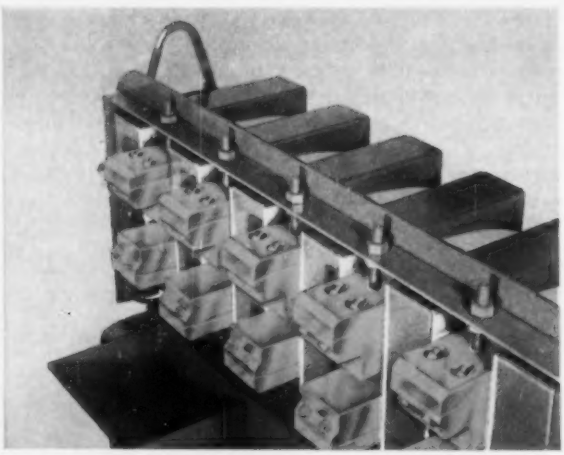
$70 COST CUT for each electrode assembly—through use of Anaconda extruded copper shapes—helped Frank C. Cheston Co. add replaceable contact feature in its line of electric rivet heaters.



Electric rivet heaters are tough, simple machines that have for years been saving time and money in riveting operations. But Frank C. Cheston Co., Newark, N. J., saw a chance to save its customers some money in maintenance, too, by making electrode-assembly contacts easy to remove for resurfacing or replacement.

Originally these contacts were integral with the laminated copper conductor forming a one-turn secondary in the step-down transformer. In redesign, only parent blocks (1, at left) are welded to the conductor. Contact shoes (2 and 3), which mate precisely with parent blocks for unimpaired conductivity, are easily removed by unbolting*.

Machining pieces 1, 2, and 3 from copper bar stock ran costs so high that the price of the heater would have become unrealistic. American Brass specialists were consulted and precisely shaped extrusions of high-conductivity copper were produced, from which the finished sections are cut. Tolerances were closer and surfaces finer than with machining—and costs per electrode assembly were cut $70.



Close-up of a 5-electrode Cheston electric rivet heater with the new removable contact feature for easier maintenance. Savings from use of Anaconda extrusions enabled Cheston to include this new feature at practically the same price as heaters of previous design.

Cheston electric rivet heater in use showing how step-design of upper contact (2, in illustration above, left) makes it easy to heat both long and short rivets. Contacts are opened by foot pedal and contact pressure is maintained by springs seen just above the pedal.

CUTTING shop costs may be easier than you think. Take a fresh look at the way you're making metal parts. Make a note of any part you suspect might benefit by the use of extrusions, special-shaped tube, die-pressed forgings, etc. Then call in your American Brass Company representative and talk it over with him. He will see that your problem gets to the right Anaconda technical specialists promptly and will expedite the answer. Or write: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda Brass, Ltd., New Toronto, Ontario.

5858

**Bolts are of Everdur®, Anaconda copper-silicon alloy.*

DIE-PRESSED FORGINGS · SPECIAL-SHAPED TUBES
EXTRUSIONS · FABRICATED METAL PARTS

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Made by The American Brass Company

tifying the map. The name stuck and is now on all maps as the lake's official name.

A new twist in mapmaking is the authentic 3-D maps of geographical areas and Civil War battlefields. These resulted from a government-sponsored project to make pre-printed, colored plastic relief maps during the second world war. It was found that by vacuum-forming pre-printed plastic sheets a 3-D map could be produced which was quite accurate. This same vacuum-forming process, described on page 56, now accounts for about 60 million pounds of sheet plastic per year. Although plastic contour maps may be fine for military purposes, they would be far too awkward to fit in a glove compartment. We'll have to stick with the multicolored 2-D maps obtainable at the local gas station.

Although mapmaking dates back 4500 years the familiar touring map is only as old as the automobile age. The first road map appeared in the Chicago *Times-Herald* in 1895. A Thanksgiving Day auto race was to be held from Jackson Park to Waukegan and the newspaper printed a multi-colored map showing the route the racers would take. Naturally, roadsigns or route markers were unknown so the driver would be guided by a note on his map saying "Chicken farm" or "red barn." In 1905 the Hartford Rubber Co published a guidebook describing how to motor about the country. It contained maps along with text and used photos to indicate complicated intersections.

About this time the Rand McNally Company started printing roadmaps with routes marked to correspond with cardboard symbols it placed on telephone poles. It sold maps using the slogan "Follow the Blazed Trail" until the cardboard signs began appearing in more boys' bedrooms than on poles. Symbols were then painted on the poles and the slogan changed to "Follow the Painted Poles." By 1913 the Gulf Oil Co sent its customers 10,000 free maps as a promotion scheme. The idea caught on and three years later they were giving away 16 million.

Locked With a Bang

Ever since the first man had his first possession he had to find a way to keep it secure. How he developed the lock and key is not known, but archeologists have unearthed locks dating back to Egypt 4000 years ago. (Amazingly enough, these oldest locks are similar in principle to the modern pintumbler cylinder lock developed in 1868 by Linus Yale, Jr.) The early "Egyptian type" lock remained popular until 1192 AD when King Richard the Lion-hearted placed a wood lock (lignum vitae) on the gate of the Holy Sepulcher. For the next 600 years, millions of pilgrims flocked to Jerusalem to kneel and kiss the lock.

Greek locksmiths made it possible for a door to be locked or unlocked from either side but made keys so big that they had to be carried over the shoulder. Romans incorporated the Egyptian principle. Because they wore pocketless togas, they wore their keys on their fingers in the shape of "ring keys." There have been and are today a great many devices for locking one object to another (p 66) or keeping a door or container from being opened by unwanted persons.

One of the most interesting locks is the heavy brass gun lock pictured here. It's now in the Yale Lock Collection and was used 150 years ago as a burglar alarm. One of the percussion caps seen lying in the foreground was inserted through the rectangular hole in the upper right-hand portion of the lock. When an intruder turned the doorknob, a trigger within the lock exploded the percussion cap with a loud report. Note the gas escape chamber at the top right-hand section of the lock. This would still be a useful idea.

Get a Horse

Back when motoring was beginning to put the horse back to pasture, the early cars were exactly what they claimed to be—horseless carriages. An engine was added to the familiar carriage body and called an automobile. One of the early pioneers, George B. Selden, mounted an internal combustion engine on the front axle. To go backwards, the axle was simply turned 180°. Front-end drive is still with us—its being adopted by the Mack Truck Co and is pictured on page 55. Some early auto makers advertised that by adding their engine and tiller you could convert your horsedrawn carriage to a modern auto-car.

Because the horse pulled, it was only natural to keep the car's power source up front. The first to try a power-in-the-rear car was Ransom E. Olds of Lansing, Mich. He built a steam car that looked like a surrey with a boiler on the back. It ran 15 miles on a tank of water and 40 miles on a filling of kerosene. Olds said, "it never kicks or bites, never tires on long runs, and never sweats in hot weather. It does not require care in the stable and only eats while on the road." Remember, in the good old days, kerosene was cheaper than hay.

—Benedict A. Leerburger Jr

Weldability—Welding is the only technique that we can use to join two pieces of metal so that they act as a single piece of metal.

Not *all* metals. Steel stands alone as the most weldable of all practical metals. Not *all* steels, but most of them can be welded without any sacrifice of strength or elastic behavior. More than that, steel can usually be welded without special precautions, without critical timing procedures, without excessive heat input, without elaborate and corrosive fluxes, without color change in the base metal, and with little danger of cracking. Welding engineers deserve most of the credit for the fact that steel can be welded so easily. With their help, steel producers have made many important break-throughs.

Before the 1930's, carbon and manganese were the main strength-producing elements in steel. Designers wanted stronger steels so they could build lighter structures—and they wanted to *weld* these steels because there is no lighter fastening system. But as the carbon content was raised to strengthen the steels, the weldability decreased and designers were handicapped because they had to fasten "lightweight" high carbon steels with heavy rivet and gusset-plate assemblies.

In 1933 United States Steel introduced the first *low carbon*, high-strength, low-alloy steel—USS COR-TEN Steel—and later USS TRI-TEN Steel. Both steels achieved 50,000 psi minimum yield strength with alloying elements other than carbon, and could be welded with normal procedures. The world of alloy steels was brightened, too, with the introduction a few years ago of USS "T-1" Steel, a constructional alloy steel combining tremendous strength (100,000 psi min. yield strength), toughness *and* weldability without requiring preheating or stress relief.

No matter what combination of properties you desire in a steel, there is a weldable steel that will do the job. In fact, there is theoretically *one* best steel for any application, and it can be selected from our family of Steels for Design: Carbon, High Strength, Alloy and Stainless. If you could use help in finding it, check United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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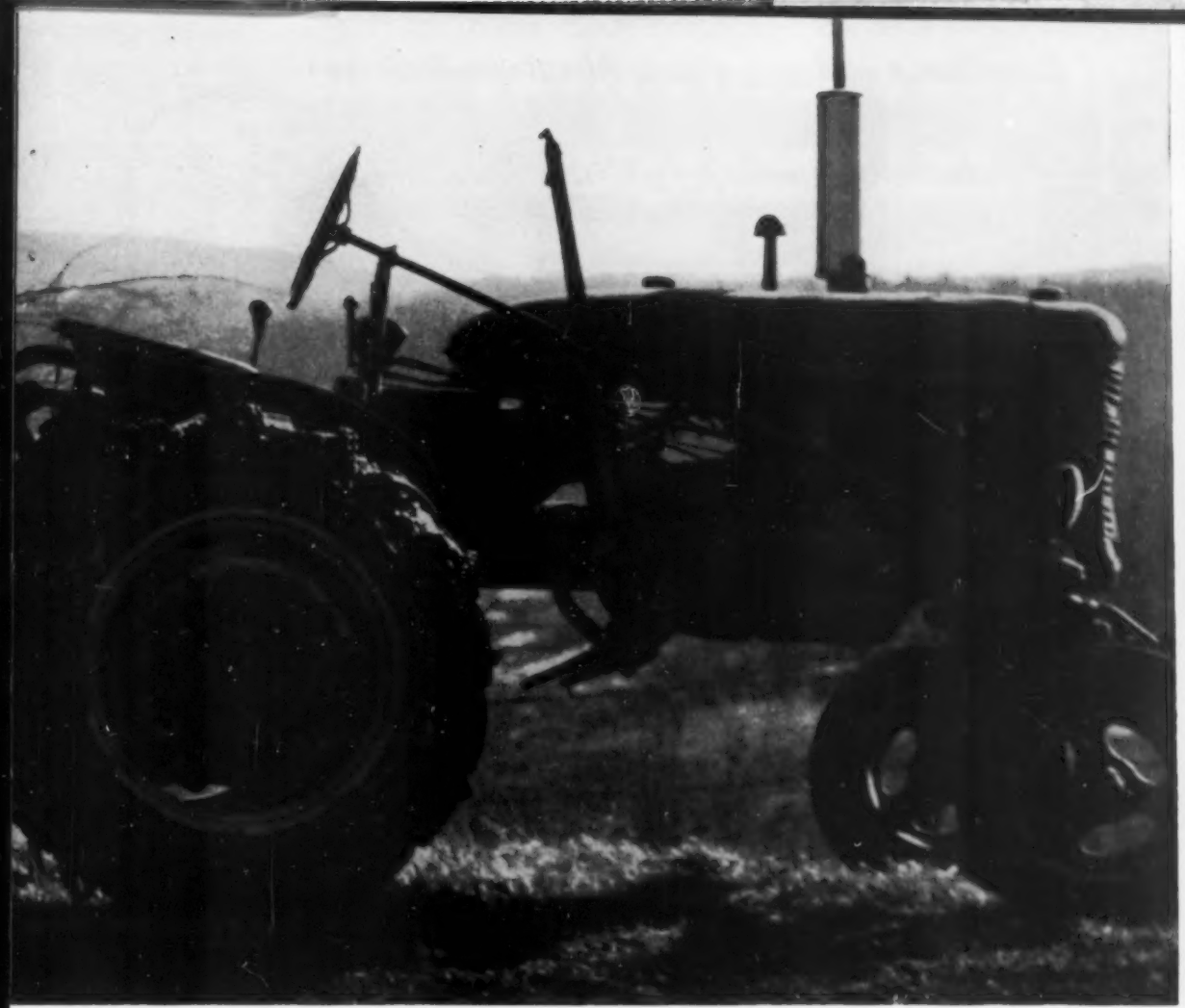
USS United States Steel

STEELS FOR DESIGN

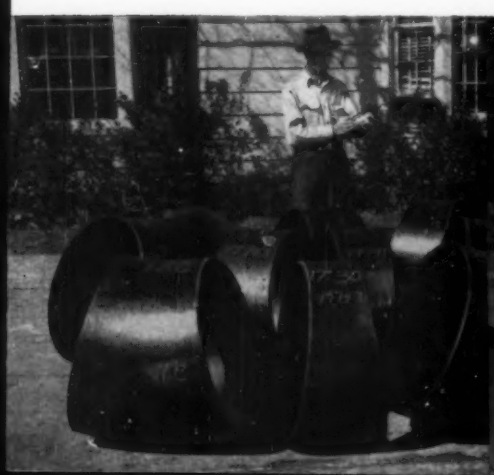


Lower Left—Problem: Design butt-weld fittings for high-pressure oil and gas lines. Solution: Designer used USS TRI-TEN Steel, a high-strength, low-alloy steel particularly noted for its weldability. Pay-off: Fittings made lighter due to thinner plates; welding was fast and easy; less weld metal was needed; and the weld was as strong as the parent metal.

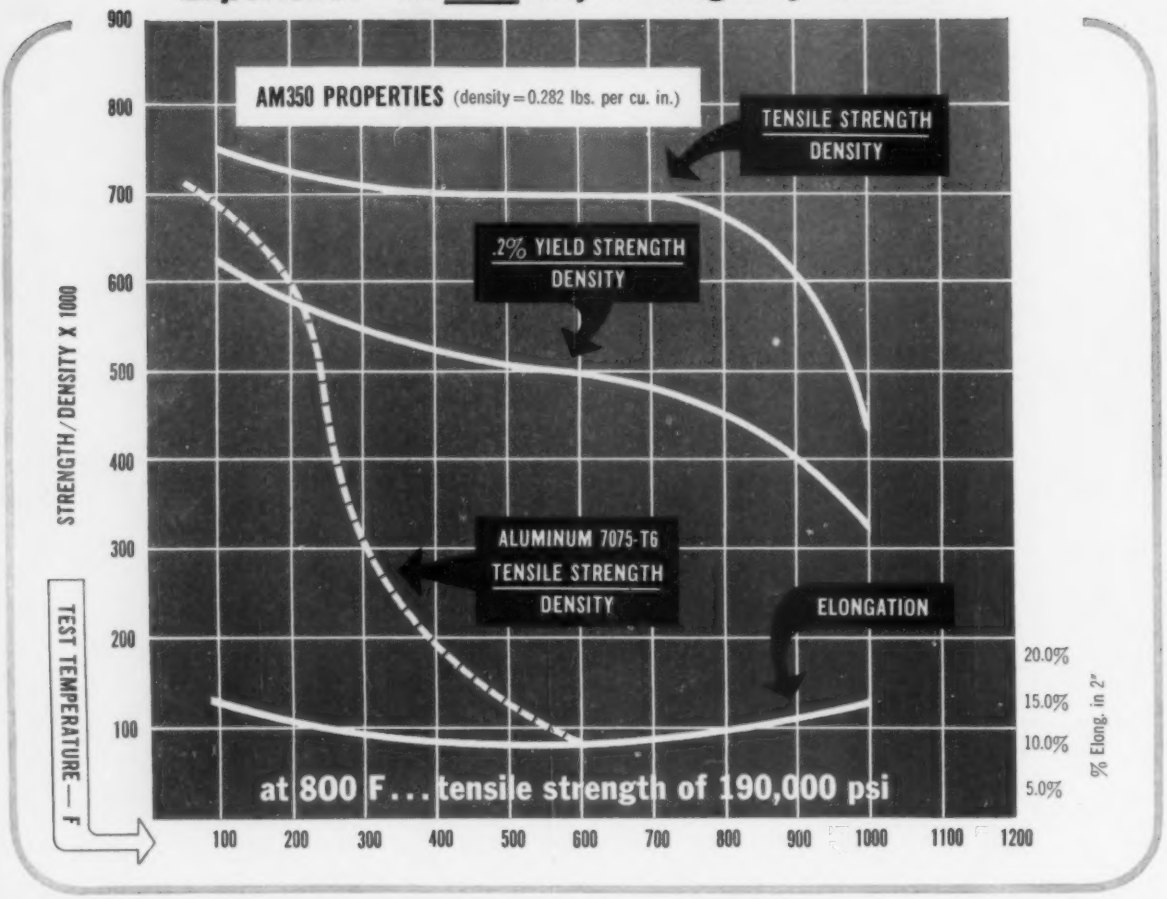
Lower Middle—Problem: Build a bedplate for a printing press requiring 534 welds. Solution: Builder used USS "T-1" Constructional Alloy Steel. Pay-off: Tremendous strength and toughness of "T-1" withstands thunderous impact from high-speed printing rollers and cutting knives—*and not one weld has failed.*

Lower Right—Problem: Convert a concrete reservoir into a storage area for 2,000,000 gallons of ammonium nitrate. Solution: Reservoir was lined with corrosion-resistant USS Stainless Steel sheets. Pay-off: Quick, easy installation because the Stainless sheets were welded right on the job—3½ *miles* of lap seams were welded and only two tiny imperfections were found when the welds were vacuum tested.

USS, "T-1," Cor-Ten and Tri-Ten are registered trademarks



Experience**—the extra alloy in **Allegheny Stainless



Here are the facts on AM350 and AM355, Allegheny Ludlum's precipitation hardening stainless steels

A unique combination of highly desirable properties is the usual description of Allegheny Stainless AM350 and AM355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many problems of the air age. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM350 and AM355.

Availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available in forgings, forging billets, plate, bar and wire.

Corrosion resistant: Being stainless steels, these alloys resist corrosion and oxidation. Compared to the older, more familiar stainless grades, their corrosion rating is better than the hardenable grades (chromium martensitic) but generally less than the old corrosion resistant standbys, the 18 and 8's. Stress corrosion is resisted at much higher hardness levels than with martensitic stainless.

Simple heat treatment: High strength is developed by two methods, both involving less than ordinary temperatures and minimizing oxidation and distortion problems. The most popular, and one that develops slightly better properties, is the Allegheny Ludlum developed sub-zero cooling and tempering (SCT condition). The material is held at minus 100 F for 3 hrs plus 3 hrs at 850 F. Alternate method is Double Aged (DA): 2 hrs at 1375 F plus 2 hrs at 850 F.

Easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using similar procedures as with the 18-8 stainless types. In the hardened condition (SCT & DA) some forming may be done . . . 180 degree bend over a 3T radius pin. Also it can be dimpled in the hard condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*** Address Dept. PE-12.

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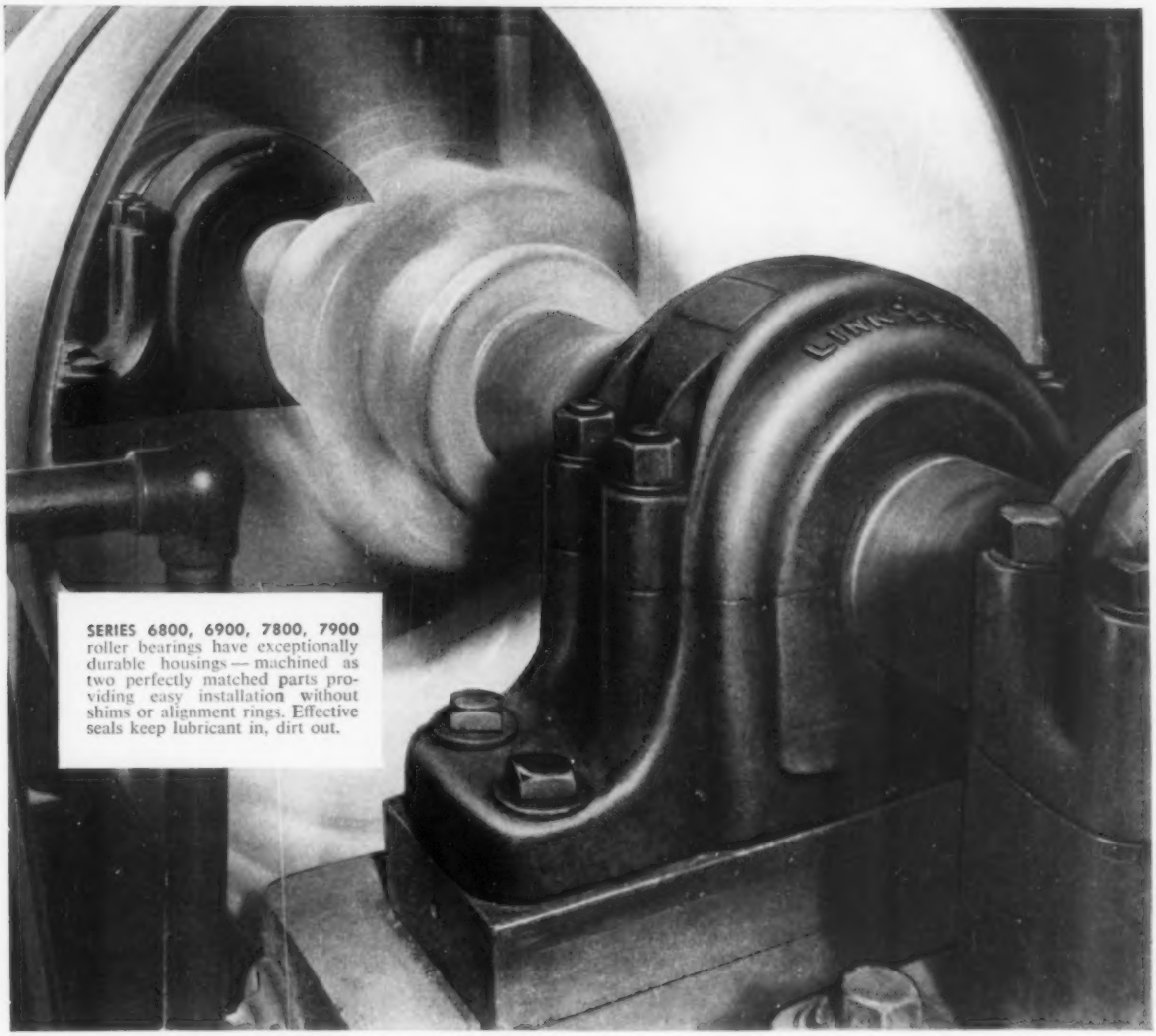
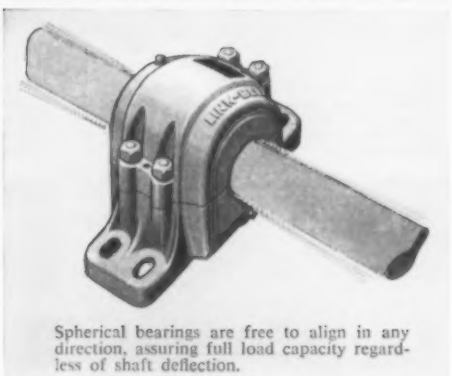


SERIES 6800, 6900, 7800, 7900 roller bearings have exceptionally durable housings — machined as two perfectly matched parts providing easy installation without shims or alignment rings. Effective seals keep lubricant in, dirt out.

These husky bearings in husky housings adjust *instantly* to shaft misalignment

Shaft deflection often means quick failure for ordinary bearings . . . but not for these rugged Link-Belt *self-aligning* bearings. Adjusting immediately in any direction, they easily compensate for misalignment . . . avoid damaging "pinch" and bind.

You can get full information on Link-Belt's complete bearing line from any one of 40 Link-Belt offices.



Spherical bearings are free to align in any direction, assuring full load capacity regardless of shaft deflection.

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Now! Plan Ahead, Be Ahead with the Years-Ahead

NEW BRUNING COPYFLEX 675

Never before has a reproduction machine offered you so much to boost printmaking production, convenience and quality!

Never before has a reproduction machine been so "planned ahead" that it actually gives you **today** *the features you'll want and need* **tomorrow***!*

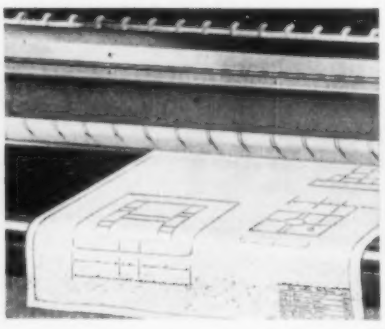
Now, in Bruning's great new Copyflex Model 675, you get such radically advanced operational features as an exclusive four-way tracing tray that can be adjusted to stack or to permit fast removal of tracings . . . a unique system of vacuum ports in the feedboard that hold large sheets and roll stock in position . . . a feeder band system that eliminates curling and wrinkling of tracings . . . enclosed, easy-to-load feed rods for roll stock . . . an electrically controlled machine height adjustment. These and many other features speed and simplify the operator's work as never before!

Providing optimum printmaking capacity are the 675's full 46-inch printing width for taking sheets and roll stock up to 42" wide . . . a mechanical speed of up to 75 f.p.m. . . . and a fast-printing 7,500 watt lamp variable to 5,000 watts at the flick of a switch. Add to these a new filtered air system that assures a cleaner lamp cylinder, cleaner prints, and a consistently high rate of output. For extra speed and flexibility, a new split-shade lamp control enables simultaneous insertion of materials calling for different printing speeds.

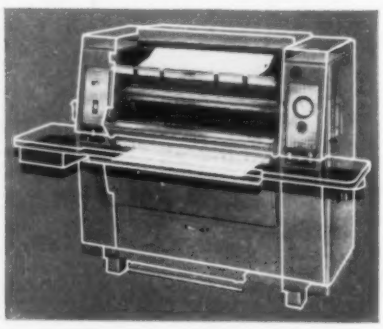
All this and more is yours *now* in Bruning's all-new Copyflex Model 675! Available on convenient Lease-Purchase Plan. The coupon will bring you free descriptive literature.

New front tracing tray can be adjusted in length to stack tracings up to 14 inches wide or up to 24 inches wide. Tray adjusts to stack tracings or to allow fast removal for re-insertion.

Vacuum ports on and below feedboard hold sheets and roll stock in position. Feeding is faster and easier. Smoothening action of feeder bands simplifies feeding, combats curling, improves print quality.



The ideal height for short or tall operators—sitting or standing! Motor-driven floor jacks enable operator to select most comfortable, efficient machine height at the touch of a switch. Feedboard height range is 35" to 39".



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Please send me more information on the new Copyflex Model 675.

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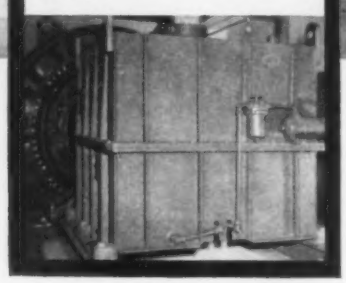
(Above) Cutting 64 inch spiral bevel gear on new precision gear generator.

(Below) Interior of rotor test stand showing Philadelphia Spiral Bevel Reducer. 1300 hp motor is in background.



Special 1300 hp Philadelphia Reducer drives helicopter rotor test rig...

Testing 90-foot helicopter rotors involved problems of torque and vibration, plus precise speed control and test rig maintenance. Kaman Aircraft Corp., Bloomfield, Conn., found the answer in a special spiral bevel Philadelphia Reducer driven by a 1300 hp variable speed DC motor.

This Philadelphia designed drive completely eliminated vibration and torque variation previously encountered in engine driven rigs. Maintenance is simpler. Precise speed control can be obtained at rotor speeds from 200 to 400 rpm.

For any right angle drive application, standard or special, Philadelphia Spiral Bevel-Helical Reducers will take more abuse and last longer under the most severe load conditions. One of the reasons is that all Philadelphia spiral bevel gears and pinions are heat treated and hardened *after* they are cut . . . then lapped to a mirror-like finish. Helical Gearing is precision hobbed on the newest, most modern equipment. The gear teeth are then crown shaved and induction hardened.

Result: better tooth contact, longer gear life. Units are vibration-free and quieter. On special applications, where conditions warrant, both spiral bevel and helical gearing can be furnished with precision ground teeth.

You can select a Philadelphia Spiral Bevel Reducer—or have one specially built—to suit your precise needs. Our Spiral-Bevel units provide ratios as low as 1 to 1, or as high as 238 to 1. Units are available in single, double or triple gear reductions—in both vertical and horizontal types. Catalog SB-57 describes them all. Write for your free copy today.

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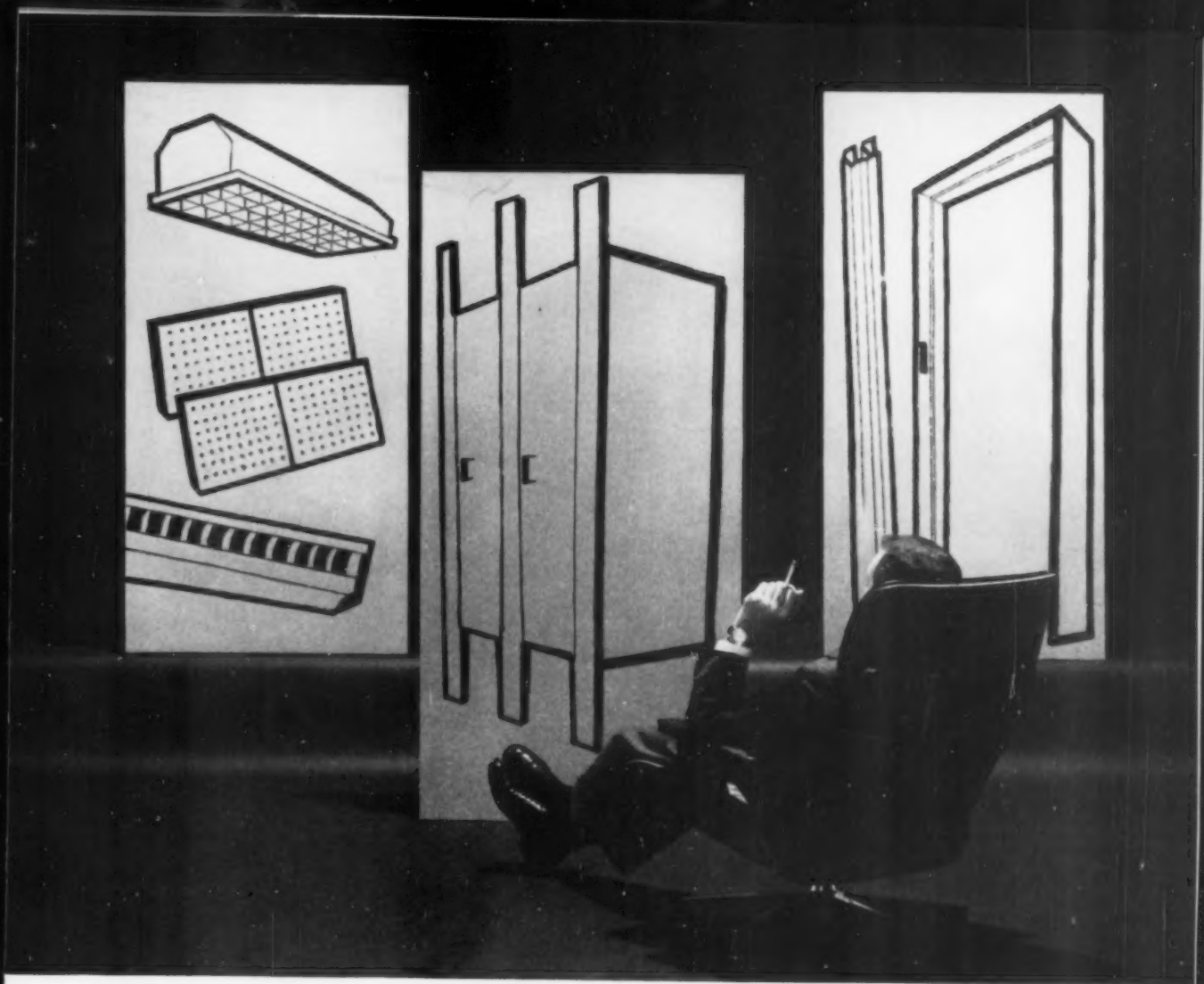

THE EASY WAY TO PREVENT CORROSION IN YOUR PRODUCT? SPECIFY ZINC-COATED STEEL SHEETS, OF COURSE!

There's just nothing like zinc-coated steel sheets for enduring, economical corrosion prevention in the products you manufacture such as light troffers, metal ceiling tiles, baseboard heating units, sliding door hardware and scores of other products.

Take the formability of such sheets, for instance. With either electrolytic or continuous process zinc-coated steel, the tight coating can take the severest fabrication operations and never flake or peel. Result: permanent corrosion resistance for longer life and lasting beauty. First cost: low. Maintenance costs: nil.

How about paintability? Electrolytically zinc-coated steel sheets, chemically treated, are unexcelled for painted products. Paint digs in and holds its unbroken smoothness and beauty for keeps.

In electrolytic zinc-coated steel, the name that stands out is Weirzin. In continuous process zinc-coated steel sheets, it's Weirkote. Let us show you how Weirzin or Weirkote—or both—can help you meet your manufacturing requirements better.

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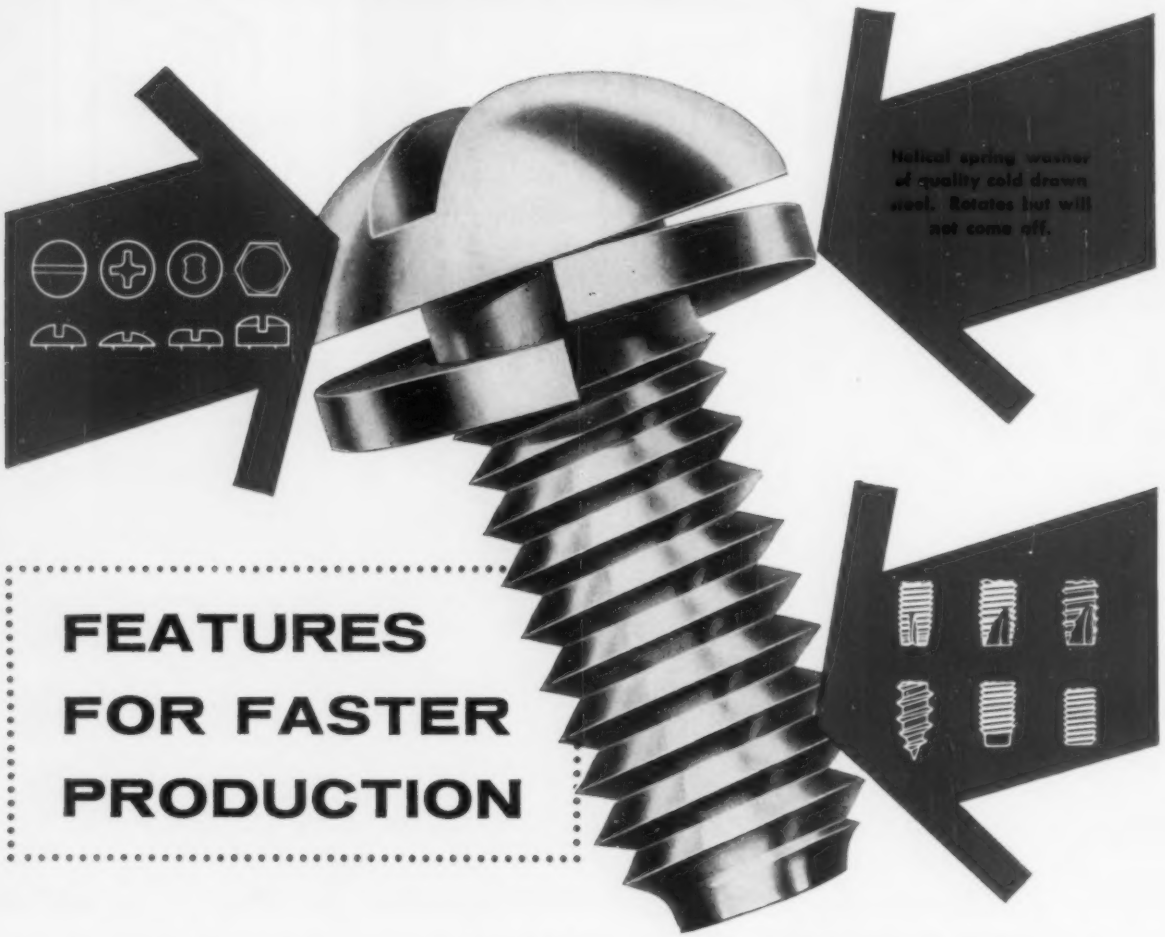

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Eaton-Reliance Springtites and Sems* are made to satisfy the needs of modern, high speed production in almost every field of metal fabricating. From design to final use, these fast fasteners offer features required by design and industrial engineers to make better, longer lasting products. With quality cold drawn steel as a foundation, Eaton-Reliance Springtites and Sems are headed and threaded on precision machines; the spring washer is added as a permanent part of the fastener and all work is inspected with a critical eye toward perfect performance under the most trying conditions. Products fastened with Eaton-Reliance industrial fasteners stay "factory tight" longer. Send for Engineering Bulletin S-49, or for threadcutting Springtites and Sems in Types 1-23-25, send for Engineering Bulletin S-49-A.

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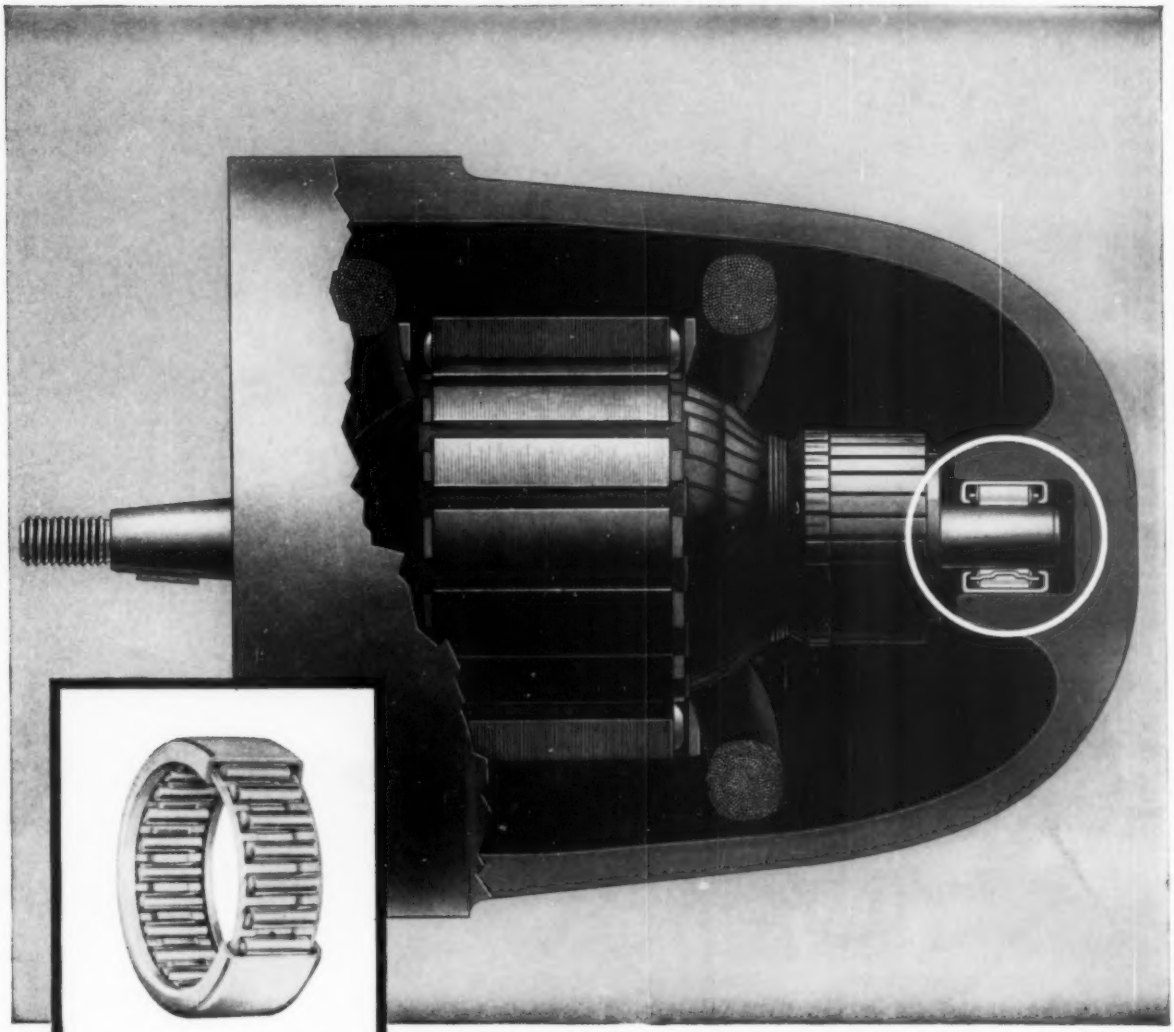

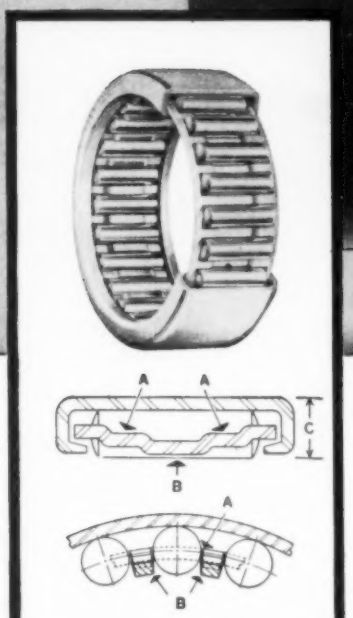

- rollers end-guided at pitch line (A)
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- long pregreased life
- efficient at high speeds
- mounted by press fit
- simple housing design
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Low unit cost of the new Torrington Drawn Cup Roller Bearing reduces armature bearing cost as much as 50%. This unique bearing gives excellent service at high speed and permits prelubrication for life.

Test installations and service applications show the bearing performs efficiently at speeds up to 25,000 rpm in intermittent service of 1000 hours and more. In such service, initial lubricant lasts the life of the motor. Most applications require no seals. This, with the simplicity of housing design, contributes further to economy.

Designers are invited to evaluate the Torrington Drawn Cup Roller Bearing for such applications as generators, power tools, electric mixers, vacuum cleaners and other appliance motors where considerations of cost, speed, efficiency and light weight are paramount.

Services of Torrington's engineering staff are offered to assist you in design developments of every type of electric motor. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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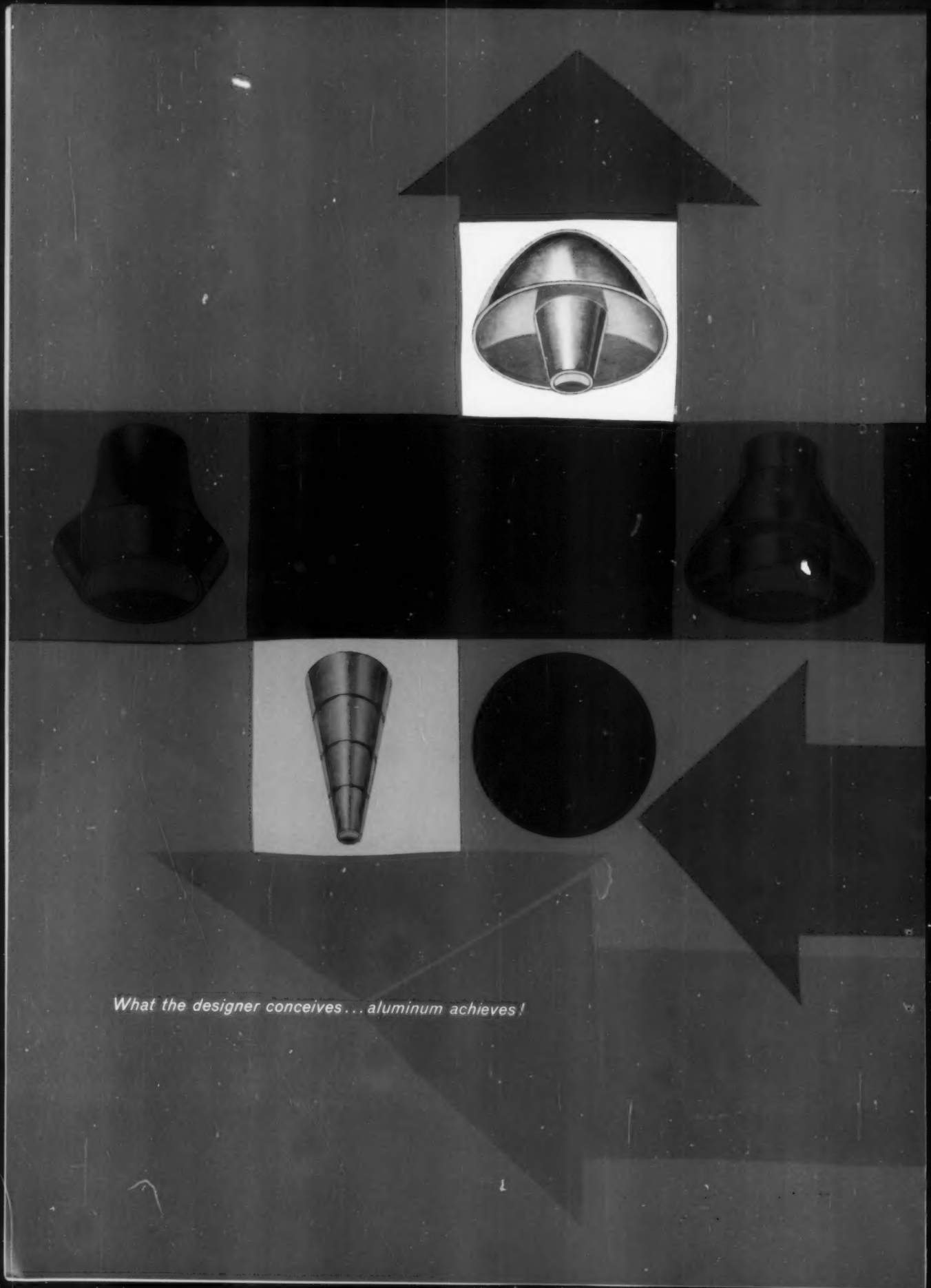

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Aluminum screw machine knobs—economical and versatile for your high quality products—offer designers infinite possibilities for styling beauty accents both with shape and with color.

In finished shapes such as the examples shown, aluminum gives sharp, clean lines . . . unusually fine "as machined" finish . . . plus the quality feel of solid metal. Low tooling cost, particularly as compared to die casting or stamping dies, adds not only initial economy but model-change versatility as well.

And for the brilliant beauty of any color, these knobs take permanent finish by one-step anodizing—usually at far less cost than chrome plating or similar plated surfaces. Aluminum offers still more useful properties, such as light weight with high strength, corrosion resistance, non-sparking and non-magnetic qualities.

If you would like design details for the parts shown here, complete with cost and production data, please send in the coupon below.

(Kaiser Aluminum does not manufacture screw machine parts, but does offer technical assistance to parts suppliers throughout the country. Contact your local screw machine products manufacturer for further information and quotations on specific parts in aluminum.)

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The need for protection in gas burner operation has been long recognized . . . and the subject of intensive research.

In 1951, a Honeywell advancement provided a "self-checking" operation at the time of burner startup . . . and spurred the search for full-time protection, because flame-safeguard components can and do fail "unsafely."

Now Honeywell, first again, offers a self-checking circuit that *continuously* supervises all system components. Never before has there been such complete protection . . . *protection you can't afford to be without.* Write for Specification S1015-5.

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First in Control

""A significant technical advancement" . . . at the A.G.A. Convention, Parade of Gas Progress.*

DEVELOPMENTS TO WATCH...

At least half a dozen new materials . . .

. . . with boron or lithium as the essential ingredient, are ready for design evaluation as radiation shields, Oak Ridge National Laboratory reports. Among them: lithium hydride, a low-density neutron shield; a magnesium-lithium alloy, coated with aluminum to prevent corrosion; and lithium oxide clad in aluminum. A lithium-clad alloy, containing 0.7% Li by weight, has also been developed for instrument shielding.

For higher temperature applications, a combination of boron carbide and copper, clad with stainless steel, shows considerable promise. It is now possible to make materials of this type with boron carbide contents as high as 30% by weight, E. P. Blizard of Oak Ridge says.

Tungsten carbide bonded with a low-conductivity alloy (to minimize heat transfer) is also being tested for applications where heat as well as radiation damage must be considered.

Another member of the boron group, boral (a mixture of boron carbide and aluminum, clad with aluminum), is already in use, but development work on this material, too, is continuing. Recent tests indicate finer boron carbide powders and improved processing techniques are needed if critical specifications are to be met.

Lower prices for nylon industrial fiber . . .

. . . to spur its use in tires, conveyor belts, and other mechanical goods, are forecast by increasing supplies of caprolactam, starting point for nylon 6.

If current construction and expansion plans go through, caprolactam capacity will more than double in 1959; double again in 1960. Furthermore, one new producer, DuPont, has already announced it intends to bring the price down at least 15% when its 50-million-lb plant comes onstream.

(Prices for nylon molding resin are not as likely to be affected by this development. Nylon 66, most popular molding material, has a different chemical starting point.)

There is another factor putting pressure on nylon fiber prices: intensified competition from rayon tire cord. Producers of this material have recently formed American Tyrex Corp with the specific aim of holding their markets against nylon "invasion."

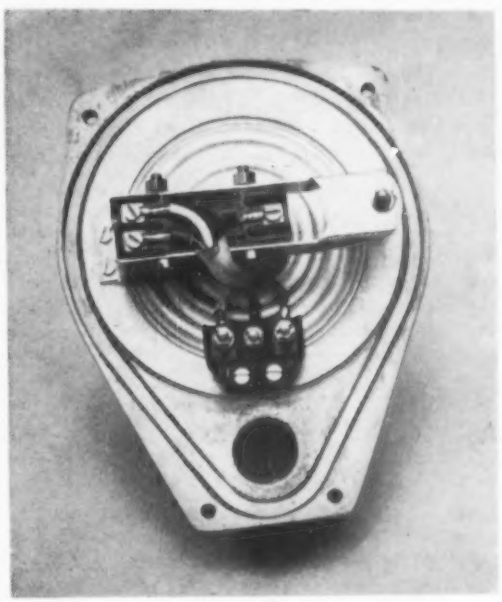
Liquid-level switch . . .

. . . operated by a metal diaphragm that "distends proportionately to the head of liquid in the tank, thus actuates the switch mechanism," has been designed in England.

There are two models; one, for single-level control, is priced at about $19 (US equivalent); the other, for 2-level use, and adaptable for 3-level operation, will cost about $2.50 more.

With the single-level instrument, a single-pole change-over snap-action switch rated at 5 amp at 250 v, 50 cps is used. The 2-level model, though, has spring leaf contacts rated at 500 ma at 6 v. Because of this low rating, the manufacturer, K-D-G Instruments Ltd, Manor Royal, Crawley, Sussex, says "suitable protection against arcing is desirable and therefore it is usual to provide a relay unit which incorporates this low-voltage control circuit."

(Note: For information on US approaches to the liquid-level control problem, see *PE*—Oct 7 '57, p 6 and Nov 10 '58, p 112.)



Pressure switch from England, for liquid-level control, is shown with cover removed. Note simple, rugged design.

DEVELOPMENTS

TO WATCH...

Improved electrical insulation and pressure-sensitive tapes . . .

. . . are promised by Johns-Manville from its new Dutch Brand plant and laboratory in Chicago.

New adhesives coming from the lab and new equipment in the plant, says J-M vice-president E. F. Boyle, make it possible to create combination materials that could not previously be made on a production basis. Among those now on test: metal foil reinforced by plastic strands and laminated to asbestos for use as wrapped insulation; reinforced Mylar polyester film for mica supports and insulators; and tissue-thin high-strength, fire-retardent asbestos paper.

Nickel-chromium coatings can protect molybdenum . . .

. . . at temperatures at least to 2000 F for extended periods, says National Bureau of Standards.

Tests of electrodeposited nickel-on-chromium coatings show that oxidation of the base metal can be prevented for over 1000 hr at 1630 F, and over 300 hr at 2000 F. The coatings have good ductility too.

To get such results, though, both preparation of the base metal and deposition technique are extremely important. NBS researchers etched the molybdenum and deposited a 1-mil chromium layer; then etched the samples again, applied a nickel strike and a 7-mil nickel plate.

Thin metal films as corrosion indicators . . .

. . . are a possibility, say Georgia Institute of Technology engineers in a report to Wright Air Development Center.

The corrosion rate of vacuum-deposited layers of such metals as iron and manganese on glass, and of such bimetal combinations as iron-copper and iron-gold, can be so closely controlled as to give a clear indication not only of amount of corrosion but also of length of time of exposure. An important element permitting this control is the adsorbed layer of gas on the glass base. This layer supplies the oxygen that initiates corrosion of the metal by setting up tiny electrolytic cells on the surface of the metal from which oxidation proceeds.

Further, it has been found that action of the adsorbed layer can be controlled by introducing cathodic particles which, in effect, interfere with the electrolytic action.

A report on the work is obtainable from OTS. It's PB 131894 (98 pp, $2.25).

Rust preventives and lubricants . . .

. . . can be made from rice oil, says Comet Rice Mills, of Houston, Tex. Drying agents, too, can be made from the material—agents to prevent dirt from sticking to oily surfaces. Comet is test-marketing several grades in its area, and also supplies the crude oil, at prices ranging from $2 to $3.50 a gallon. Flash points range from 450 to 520 F, fire points from 500 to 620 F. Refractive index is about 1.48.

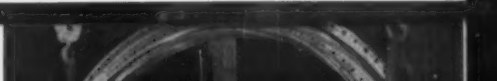
Contact "bounce" is eliminated by a new relay design . . .

. . . soon to be introduced by General Electric's Appliance Control Dept. Of special use in air-conditioning systems, the new contactor will feature 25-amp rating, and ½-lb contact pressure "for positive make-and-break action with a minimum of wear." (For additional information, see coming Jan 6 issue.)

Transistorized, low-voltage ignition systems . . .

. . . being developed by Electric Auto-Lite for engines with compression ratios of 12 to 1 or more, feature "unique spark plugs that surface-discharge through a semiconductor, a rotary gap distributor with rare-metal contact points"; also incorporate a step-up transformer, high-peak inverse voltage rectifier, and an oil-filled discharge capacitor. Auto-Lite foresees first applications in military combat vehicles; but believes the system eventually will make it possible to produce a unit for passenger cars and other applications that will "extend spark-plug life well beyond present limits." —ARG

THE ENGINEERING WEEK



Testing Polaris—Product Engineering Goes Aboard Ship to See It Done

NORFOLK, VA.—Final proving ground of the Navy's 1500-mile, solid-fuled Polaris missile—the USS Observation Island—will be putting to sea any day now. The ship, a converted mariner-class merchant vessel, is outfitted exactly like the Fleet Ballistic Missile submarines now under construction. The first FBM, the George Washington, will be launched at Groton, Conn., next spring. A total of nine have been authorized.

Before the new FBM submarines roam the seas with their lethal, nuclear-warhead missiles in 1960, full-scale Polaris missiles will be fired from the Observation Island. This will be last step before the missiles are actually test-fired from submarines.

The Observation Island was formerly a merchant ship. Its innards were stripped and replaced with rooms of electronic gear, the new SINS (Ships Inertial Navigation System), and compressor for ejecting the missile. The vessel now also has a special closed-circuit TV system with multiple cameras, and a firing tube that reaches to bowels of the ship.

PRODUCT ENGINEERING *(in the person of Seth Payne, Washington editor,)* recently observed an actual test-firing aboard the Observation Island, while she was at her dockside berth in the Norfolk Navy Shipyard, and made the exclusive pictures shown. Details and much of the equipment remain highly classified. Purpose of the firing was to test the ejection system and determine the amount of shock that internal instruments must withstand.

Hours before the test, engineers aboard the ship started ballasting the vessel so it would have a 7 deg starboard list at firing time. This was to make sure the ejected missile wouldn't fall back onto the ship. (The same precaution will be used aboard the Polaris-toting submarines when they fire the missiles).

As firing time approached, civilian and Navy technicians checked out equipment. Cameras were readied. So was the firing tube, stuffed with its 15-ton slug of steel and concrete. Remote hydraulic controls swung the watertight lid clear and the compressed air ejection system was readied.

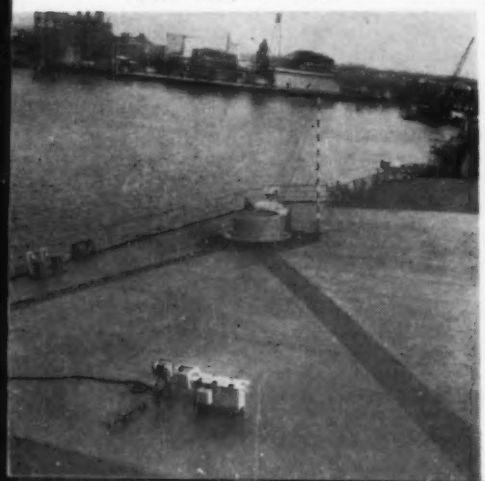
Minutes before the firing, personnel were cleared from the firing area and observers took positions high up on the ship. Safety checkoffs were reported into the safety observation station. Then it received a final report that the missile was ready to fire. After a 20-sec countdown, the huge slug roared out of the firing tube. It reached a height of over 100 ft, then dropped about 75 ft away from the ship into some 40 ft of water. While in mid-air, the nose of the slug—with a nylon rope attached—was separated from the missile and dropped to serve as a marker buoy for the retrieving crane.

Polaris test-ship Observation Island

So far, the dummy slugs—with the same weight, general size and center of gravity as the actual missile—have only been plummeted about 150 ft in the air. They will be thrown much higher in later shots to test varying operating depth for submarines.

In actual operation, the submarine must eject a Polaris clear of the water. Then, when it reaches predetermined height, its solid-fuel rocket will be ignited by a timer inside the missile—and it will be on its 1500-mi flight.

Compressors will provide a central air supply for the 16 missile tubes that the submarines are unofficially reported to be carrying. Once charged, the ejection system can be held for an indefinite time before firing. If a fir-



Dock-side missile test . . . from the Observation Island shows at left a Polaris launching tube uncovered and ready for shoot. Tube stands about 4 ft above deck, is about 54 in. dia. . .

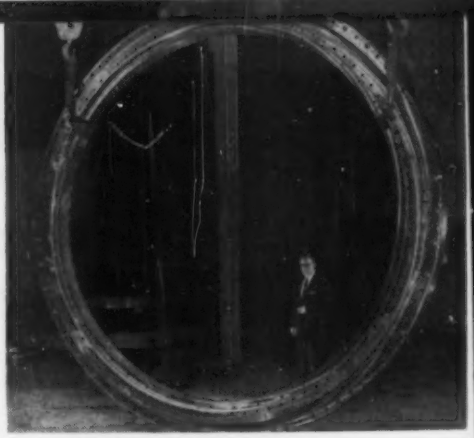
. . . Center, 15-ton dummy slug is stopped by camera as it leaves the tube. Traces of vaporizing compressed air from ejection system are just visible. Below, crane retrives slug from water for later shoots.

ing is scrubbed, the system can be de-charged. The missile will actually be fired through a plastic diaphragm. This will keep out water while the tube is uncovered.

The shot described above was the seventh fired from the ship while it has been at Norfolk. The first was fired on November 13. The Observation Island will leave soon on shakedown cruise to the Naval base at Guantanamo Bay, Cuba, and in February, go to its new home at Cape Canaveral, Fla. As more Polaris components are completed, they will be test-fired from this ship.

First firings of the completed Polaris are expected to begin in March from launching pads at Canaveral. The next step will be firing the missile from a ship-motion simulator at Cape Canaveral. Then, the completed missile will be fired from the Observation Island—last step before test firings from the new FBM submarines.

Navy expects to keep the Observation Island busy as a test ship for some time—to try out Polaris refinements as new technical advances are made. Moreover, there are unofficial reports that the missile may eventually be put on surface vessels such as cruisers and aircraft carriers—another reason for keeping the test ship handy.



Huge 14-ft dia ball bearing . . .
one of a pair for a radar pedestal was computer designed for combined loads up to 1,000,000 lb.

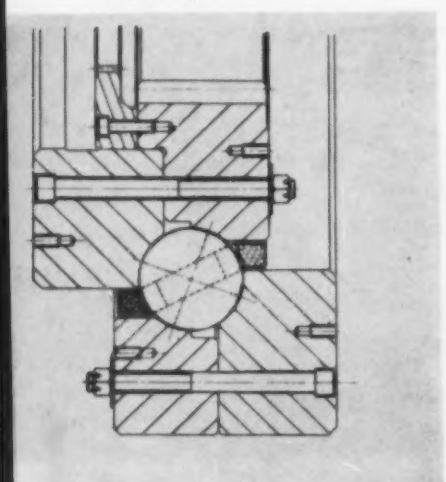
World's Largest Ball Bearing

MUSKEGON, MICH—The largest precision ball bearing ever fabricated, nearly 14 ft in dia with 88 4-in balls will soon be installed in the supporting pedestal of a Nike-Zeus radar system. Made by the Kaydon Engineering Corp, the bearing is designed to carry a rotating dead weight of 1,000,000 lb, larger than any known continuously rotating mass. The bearing will rotate at 10 rpm during a minimum operating life of 10 years.

Increasing demand for range and accuracy in radar systems is responsible for this trend to larger bearings. A 60 ft diameter bearing is now being designed with replaceable segments; diameters of 100 ft are coming.

Bearing parallelism determines the accuracy of the radar beam as the antenna rotates, particularly as beam range increases. To obtain parallel bearing surfaces in the unit shown here bearing diameter was held to a tolerance of 0.002 in. To precision grind this bearing the Frauenthal Division of Kaydon produced the largest precision grinder ever made; it will take bearings up to 15 ft in diameter.

Four races . . .
support 4-in balls to carry combined radial, thrust and overturning loads in one bearing.



In the design of the bearing, data covering static, dynamic and survival, conditions were processed by an IBM digital computer, to determine bearing size, bearing type, and number and size of balls. The loads involved called for 4-in diameter high-carbon chrome-steel balls—the largest thus far used for continuous rotation—with four points of contact on each ball to take radial, thrust and overturning loads. This bearing design simplified the pedestal system by avoiding separate bearings ordinarily used to take each of the three loads.

The bearing consists of five different rings: upper and lower outer race, upper and lower inner race, and a data gear ring to indicate angular position of the radar antenna. An integral drive gear cut in the lower inner race ring will mesh with a system designed to rotate the radar antenna. The drive gear was made integral to eliminate assembly errors inherent in a composite structure. The five rings were forged from SAE 8660 steel. After machining, ball grooves were flame hardened to 58-63 Rockwell C at the surface, and then Magnafluxed and given sub-zero treatment at −120 F to stabilize the steel.

All surfaces of each ring were ground with an added finish grind on mating surfaces. Mounting holes in the rings were then drilled, tapped and reamed, and the gear teeth cut. After the rings were bolted together all exterior surfaces were finish ground on the special grinder with parts resting horizontal and free. All grinding operations were completed before moving the work. The grinder and all operating and testing equipment were enclosed in a room with ambient air and grinder coolant, maintained at 71 F within 1 degree.

For transit . . .
huge bearing was mounted at a 30-deg angle, and kept in continuous rotation by a small gasoline engine to prevent fretting corrosion from road vibration.

To check temperatures and running torque all components were assembled in the same position as held in operation. The individual parts of the bearing were checked out to four-tenths of a thousand (0.0004 in.) for concentricity and parallelism making this not only the world's largest, but also the most accurate large bearing ever produced.

Shipping the bearing presented a problem in avoiding damage from fretting corrosion in transit. While resting at a 30-deg angle on a steel frame anchored to the floor of a truck trailer, the bearing was kept in continuous rotation by a drive mechanism powered by a small gasoline engine. This same drive mechanism will also be used during shipment of the radar pedestal to its site. Size and importance of the shipment required detailed planning of the truck route.

Combined Techniques Cut Drafting Time, Tedium

ROOSEVELT FIELD, NY—A drafting system that may reduce work time by 50% has been developed at Arma Div, American Bosch Arma Corp. Known as Fotogram, the system calls for drawing the original layout so that detail drawings can be directly reproduced.

By contrast, the time-consuming conventional procedure calls for (1) making layout of mechanism, (2) taking drawing apart, piece by piece, to make individual drawings of each part, adding dimensions and tolerances where necessary, and (3) putting it all together again for an assembly drawing. Here's the new approach developed by Arma engineers:

EXPLODED AND STACKED LAYOUTS

Draw each part individually—during layout. Essentially the layout man disassembles his mental image of the mechanism as he draws, exploding parts on the page in proper spatial relation to the whole. Each part is coded for proper reassembly. Layout is then copied on a conventional diazo machine and individual parts snipped from the sheet. Details and dimensions are added to these clippings which are then pasted on a standard drawing format that has a title block and space for notes. Notes are typed in or pasted on as required and the composite is photographically reproduced on vellum—thence, the master drawing.

Another way to create individual drawings is to build up layouts from stacked sheets of translucent Mylar. Each sheet represents an individual part, and drawing material is transparent enough to reveal the complete assembly when they are stacked together. Individual sheets are pasted to the standard format and copied the same as with the exploded layouts.

Which of these two methods to choose depends upon the kind of assembly. But even if layout must be done in the conventional way, Arma is using a couple of other tricks to save detailing time.

ADDING AND SUBTRACTING

Detail drawings will sometimes be made by the additive method—a photographic tracing process. From a layout, drawn the conventional way, lines are transferred to a photographic film by brushing over them with a developer solution. When exposed to a controlled light source, outlines of the individual piece appeared and it can be dimensioned and processed the same as other Fotogram drawings.

Another trick, which Arma calls the subtractive method, is similar but instead of transferring desired lines from the layout, unwanted lines are brushed out with a bleaching solution leaving only the part to be detailed.

Fotograms eliminate assembly drawings too. Prototypes are made in the model shop from Fotogram layouts and individual part drawings. As these are completed assemblies and subassemblies are photographed and the photos pasted up with title block and notes to make assembly drawings. Photographic assembly drawings made this way, claim Arma engineers, are easier to understand and read than drawings made the conventional way.

Success of the Fotogram method hinges on modern high-speed photographic reproducing techniques. Arma engineers are using nearly every trick in the bag—xerographic and ozalid reproducing processes, microfilm, Polaroid one-minute photographs, paste-on notes, and the Fotosetter machine, a high-speed composing machine for printing schematic circuits from a rough sketch.

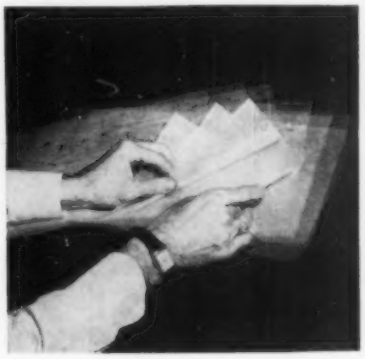
Czechs Claim Elevator Without Cables

VIENNA, AUSTRIA—The world's first elevator operating without a cable system reportedly has been developed by the Gottwaldov Works in Czechoslovakia.

The elevator system operates on the principle of both compressed and thinned air. Ventilators are used to create a sufficiently strong air pillow under the elevator to press the cage upward, while simultaneously a pumping-out of air from above the elevator helps it during the ascent.

In going down, the elevator shaft's top end is closed off, so that a thinned-out section of air is created, while the descending cabin compresses the air underneath the cabin, insuring a soft downward gliding.

These two tricks . . .
Supply Arma draftsmen with detail drawings and layouts at the same time. (Left) exploded drawing is shown behind transparent format on which the draftsman is pasting identifying legend and detailed clipping. (Center) layers peeled from stacked layout give individual detail drawings which will be pasted up same way. (Right) Completed Potogram ready two minutes after paste-up is photographed.



USSR's machine-tool industry...
is mapped in the 25th anniversary volume of ENIMS, the Machine-tool Institute in Moscow (See PE, July 14, p. 13 for details). The diagram depicts ENIMS as the single source of design for all plants, as well as a source of data for plants in satellite countries. Last year's production was reported as 130,000 units; 1960 output is expected to be 200,000. The industry has grown from about 8 plants which in 1932 produced 20,000 units, the same year the USSR imported its record total of 69,000 units.

EIA Cuts its Readings; Dallas Confab Data-Filled

DALLAS — Resistance welding causes embrittlement of materials even if the weld is good. Crimping doesn't cause embrittlement, but is uncertain mechanically and electrically. These comprised a few of many opinions offered during Electronics Industries Assoc's recent conference here on "Reliability of Electrical Connections." Opinions that follow were collected, culled and interpreted by Franklin D. Yeaple, PRODUCT ENGINEERING Associate Editor, who attended conference. (Look for an upcoming Design article on a guide to the selection of connectors.)

Conference was unique in that no technical papers were read, no separate sessions were held—rather, three days were devoted to querying authors of the predistributed papers. Here are answers offered to a few of these queries:

- Soldering coaxial cables is preferable to crimping if frequencies are in the RF range. Opinions on soldering coaxial cables allowed that crimping was still acceptable mechanically. Teflon was considered one of the best dielectrics.
- Solder tensile strength can be 6000 psi, but because of grain growth actual joint may be unreliable if over 200 to 400 psi is used. Best solder temperature was considered 100 F above melting point of solder, but the variety of ways to apply and measure heat obscured this conclusion.
- Potting is permissable for permanent components or structural use, such as reinforcing pins. Military prefers to group potted components.
- Dr. Soria, of Amphenal, who led connector discussions, considers 0.0002-in. gold plating good for low electrical resistance; helps to reduce galling.
- Convair insists that circuit boards must have more positive connections than have been achieved using edge for male portion of connection. Convair stakes terminal pins into each board, then wraps wire around the pins before soldering. Seeking to reduce effect of scratches and dust particles that spoil connections, Convair prefers standard wire harnesses with AN-type connectors—boards are not attached to boards.
- Eyelets stirred a controversy. While many argued against using them at all, others were divided on extent of clearance between OD of wire and ID of eyelet. Some thought 0.003 to 0.006 diametral clearance was enough; others wanted more leeway.
- Discussion of printed circuit boards and their connections that are subject to vibration, yielded agreement on these point: relatively mild vibrations can cause accelerations up to 900 g at center of boards; stiff-mounted cards seem most reliable; crimp connection suffices even at 2000 cps if joint is protected from stress by additional supports. The conference disagreed that bulk from joint soldering improved vibration resistance, some saying that an unrestrained joint (less than normal solder) is better. Still others held that any solder joint is unreliable.

Urge More R&D on Ultra-pure Metals

SAN ANTONIO, TEX—The production of ultra-pure metals and of highly characterized ones shows signs of becoming a major industry, Dr. A. V. Astin, director of the National Bureau of Standards, told a regional meeting of the American Chemical Society meeting here recently. But now, he said, is the time to organize to develop precision purification techniques where they do not exist.

It is in the area of fundamental research that Dr. Astin believes materials sciences are lagging. Tentative proposals have been made for setting up a multimillion-dollar national materials research center.

The NBS plans to ask Congress for money to greatly expand its effort to develop high purification techniques and to study and supply information on materials systems. Dr. Astin said the Bureau will build around established programs and create new projects to serve special needs. One of the areas of materials research, for example, where significant progress has been made is that of semiconductors. Now there is need for extensive basic research on the properties of various semiconducting materials, on improved methods for achieving purified materials, on controlled compound semiconductors, and applying these materials to various uses. NBS plans to give this field special attention.

In ceramics, another example of needed research, extensive studies are underway on the addition of the minutely added second component to highly purified materials. In metallurgy, he said, research is needed on the role of trace elements to improve pure metals. Near-pure materials with imperfections will be studied.

The Bureau's plans for enlarged research activities on high purity substances and highly characterized materials are threefold: Major emphasis will be placed on basic research to improve purification and measurement techniques and dissemination of information on these techniques and properties of basic materials; creation of a center for the "development, growth, improvement or purchase of highly pure substances for the common use of all scientists"; research on substances and techniques only in areas where there is inadequate research elsewhere.

COMING EVENTS

DECEMBER

28-30 . . . . History of Science Society, Annual Meeting, DuPont-Plaza Hotel, Washington, D. C.

JANUARY

12-14 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, Electronic Industries Association, American Society for Quality Control, 5th National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Penna.

12-16 . . . . Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

21-23 . . . . American Society for Engineering Education, Annual Mid-winter Meeting, Engineering Graphics Div, Wayne State Univ, Detroit, Mich.

26-29 . . . . American Society of Heating & Air-Conditioning Engineers, 14th International Heating and Air Conditioning Exposition, Convention Hall, Philadelphia.

27-30 . . . Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York.

READER TO EDITOR

Name the Product After the Inventor

To the Editor:

I had a few thoughts concerning a sentence in "Backpatters," (Nov 3 p 40). It was said that ". . . products don't carry the name of the engineering designer . . ." Very true, at least in the United States. But is that so good? Engineers are human (or would you say almost so?) and which human dislikes a little personal fame? Would the chance of getting one's name attached to an invention or a design not perhaps outweigh many of the "negative incentives" which drive many designers from the drawing board into jobs as administrators or shoe salesmen?

Men of science and engineering—especially in Europe—were, and have been to this day, often rewarded by being officially recognized as the "father" of their "baby" . . . Dalton's Law, Diesel engine, Otto cycle, etc.

Commercial companies may feel it unwise to attach their chief designer's name to a product of theirs, fearing that by the time the product becomes known their chief designer may have left the company to accept a job with a competitor. So this may be an understandable, though perhaps not an excusable, reason for not identifying a product with a person. Universities, where many inventions are still being made, would not have this problem; and as a nation, we would have good reason to promote identification of our technical advances with names of engineers.

Maybe "engineers don't brag in public" (is that really true?); but few refuse a medal for achievement. And to have an invention named after the inventor—well, I for one would feel this as good as getting a medal.

—W H Oettinger
San Diego, Calif.

Vinyl-clad vs Magnetic-force Welding

To the Editor:

Because we believe strongly in the character and reputation of the trade press, we feel that certain specific information regarding vinyl-clad resistance welding should be called to your attention in connection with the article on "Magnetic-force Welding" (Sept 15 '58, p 82).

There is a strong inference in your article that the magnetic-force head is the only answer for resistance-welding vinyl-clad steel. This point has been stated point-blank. Of course it is not true. Our own experiments (which were discontinued in late spring due to the press of other activities) proved that Sciaky equipment with a diaphragm head is equally as capable of projection-welding vinyl-clad steel. And as you will notice, the basic advantage of the magnetic-force head is the extremely fast follow-up effect over short weld time, which of course, we have always provided in the diaphragm-head equipment.

Knowing the characteristics limitations of projection welding, we can readily see that vinyl-clad steel in small assemblies can be satisfactorily resistance-welded with projection techniques. To manufacturers who are making small cases, this article should be of interest. However, the automotive interest is in large panels in high production where the characteristics of projection welding do not permit the use of this method of resistance welding.

We know for a fact that the exclusive manufacturer of vinyl-clad floor panels for the Ford Station Wagon is in dire need of a suitable method to fabricate this particular section. To date, neither we nor any other resistance-welding manufacturer has been able satisfactorily to meet either his high-production or weld-quality requirements! It is most unfortunate that a photo of this particular floor panel appears in your article.

Sciaky discontinued experimentations with this vinyl-clad application before exhausting all of the experimental possibilities, so we cannot state positively that resistance welding as a process is not potentially satisfactory. The limitations of projection welding are known to us and are undeniable. Likewise, we suspect the limitation of spot welding because the intense heat would discolor the vinyl-clad on the reverse side. It is strongly suspected that perhaps vinyl-clad steel will be fabricated not by resistance welding alone, but perhaps a technique of resistance welding or heating in combination with other equipment. We can prove beyond any doubt that the magnetic-head welder is not any more suited to projection welding vinyl-clad steel than our own equipment. The limitations of the magnetic-force welding equipment are well known, ie, it is complex and expensive.

Wm S Rudin
Sciaky Bros Inc, Chicago

• We are pleased to see that Mr. Rudin recognizes that welding vinyl-clad steel together is a tough problem, and that there are competitive ways to do it. We hold no particular brief either for magnetic-force or diaphragm-head equipment for making projection welds. In our article we chose to show the designer just what the magnetic-force technique is, why it is adapted to the vinyl-clad steel problems, how strong the resulting welds are, and how parts should be designed for the process. If our technical facts are in error we stand ready for correction.

But the burden of Mr. Rudin's argument appears to lie in two basic points: the article did not mention diaphragm-head equipment, which he feels is at least equally suited to projection welding; and the inclusion of a photo showing a station wagon floor panel was misleading, because nobody's technique has licked this one on a production basis. We will concede the second point to Mr. Rudin, if he will accept our judgement on what interests readers. Perhaps we should here quote a line from the Greek Thucydides in reporting a sea skirmish during the Peloponnesian war: "Both sides retired and raised trophies."—Ed.

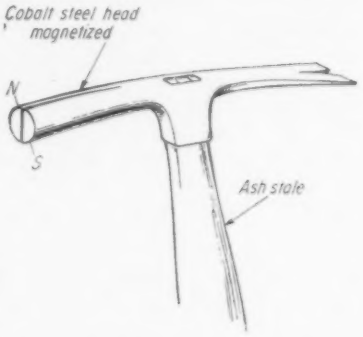
Hammer to Hold Nails

To the Editor:

You once asked about a hammer to hold and dispense nails ("Why Don't They R & D," Apr 7, p 50). I should like to tell you of a special hammer used by workers in the upholstery trade in Birmingham.

This hammer is not as heavy as the usual joiner's claw hammer. Its head is long and narrow and consists of two pieces of steel "D" sections placed back to back and welded at the shaft. These pieces are made to fit together as in the sketch, and then the whole head is hardened and magnetized. The face of the hammer, being split, will have two magnetic poles which will hold steel or iron objects.

In use, the upholsterer places a handful of tacks in his mouth and takes one tack at a time out, headfirst, from his mouth. The tacks are held in his mouth until the hammer head is brought to the lips to be charged with a fresh tack. The left hand



is holding and arranging the upholstery in readiness for tacking by the other hand. Needless to say, the upholsterers don't talk to each other very much and they dare not cough or laugh.

The tacking rate varies, and may exceed 90 per minute—during work the hammer moves so quickly that it cannot be seen.

—W Richard Marsh
Edinburgh, Scotland

Portable Steam Cleaner

To the Editor:

While reading your Nov 17 issue, under the heading, "Why Don't They Research and Develop" (p 50)—I noticed that Mr. C. McLaughlin asked, "Why doesn't someone develop a small portable steam cleaner?" Here is some information on a portable steam cleaner which we produce. Perhaps Mr. McLaughlin would be interested.

—Maurice G Finnerty
United Fabricators Inc

• The specifications describe a device 15 in. high by 9⅛ in. diameter. It draws 1600 watts at 115 v ac and will operate for 20 minutes on 2 quarts of water. You can tilt it to spray wet steam for cleaning or dry steam for drying.—Ed.

Positive Protection Against Phase Failure and Phase Reversal ?

Here is your answer!

The Allen-Bradley Bulletin 812 Type F, Type R, and Type RF relays provide positive protection against the hazards to men, motors, and driven machinery, resulting from phase failure and/or phase reversals.

The Bulletin 812 Style F phase failure relay employs a unique static sensing network that responds to all open phase conditions on a motor branch circuit and immediately removes the motor from the line . . . irrespective of the load on the motor (including no load), or the circuit arrangement. This relay even responds to hard-to-detect primary failures on a wye-delta transformer with ungrounded neutral. Furthermore, the five-cycle response prevents nuisance "drop-outs" from transient fluctuations.

The Bulletin 812 Style R phase reversal relay disconnects the motor from the line—whether it is running or not—when a phase reversal occurs anywhere in the system on the line side of the relay. Thus, it can be employed for a single motor, a group of motors, or an entire power system. In addition, the phase reversal relay prevents the motor from starting should phase failure occur while at a standstill—a vital feature for elevator applications.

The Bulletin 812 Style RF relay combines the elements of Style R and Style F relays for protection against both phase failure and phase reversal. All Bulletin 812 relays are inherently "fail safe." Send for complete information.

Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd.
Galt, Ont.

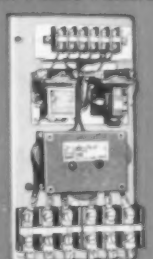
ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

12-58-MR

Bulletin 812, Style RF for Phase Failure and Phase Reversal

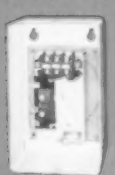
INDIVIDUAL RELAY UNITS AVAILABLE

For Phase Failure

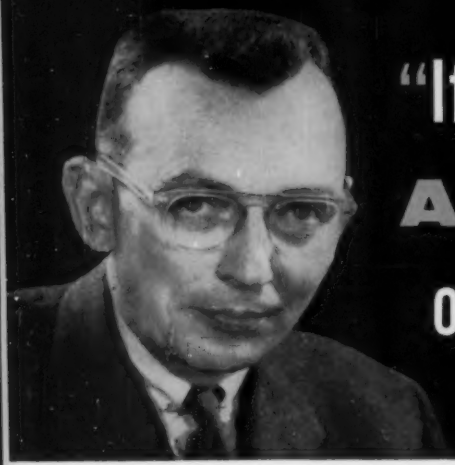


Style F covers full load currents from 1.5 to 300 amp in 4 sizes. Coils for up to 600 v, 60 cycles.

For Phase Reversal



Style R made with coils for 110, 208/220, 440, 550 v for either 50 or 60 cycle operation.



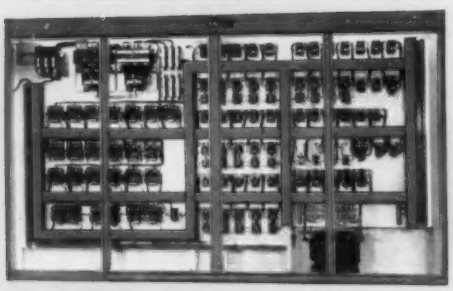
"If we stick to ALLEN-BRADLEY... our control troubles evaporate"

... so says John A. Bradner,
President, Lees-Bradner Co.,
Cleveland, Ohio, machine tool manufacturer.

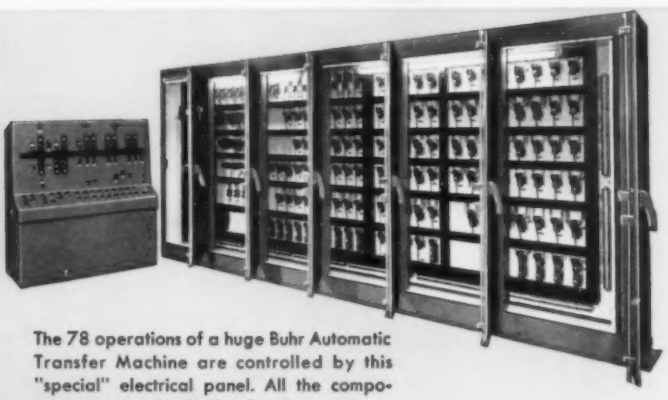
"Yes, we have chosen Allen-Bradley controls. We use them, like them, and most thoroughly approve of them. We do our level best to see that they're the ones with which LEES-BRADNER machines are equipped.

"It has been our experience in over 25 years of pioneering electrical rather than mechanical control of machine tools that, if we stick to Allen-Bradley, control troubles we are too apt to have otherwise—*evaporate!*"

Lees-Bradner Gear Hobbing Machine, above, uses six motor control panels assembled from standard A-B components.



This is the electrical control panel for a 12-station Kingsbury Indexing Automatic which performs 19 operations on an automatic transmission part. All the components in this panel are standard A-B control items.



The 78 operations of a huge Buhr Automatic Transfer Machine are controlled by this "special" electrical panel. All the components are standard Allen-Bradley units.

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

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12-58-R

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• That this is the age of specialization is certainly true in the use of steels. And in this regard *Athenia Steel* customers benefit especially by two not-too-common factors. First, by extreme control of quality and uniformity, unsurpassed, seldom equalled *anywhere!* Secondly, by painstaking technical service to determine or develop precisely the right steel for any special need.

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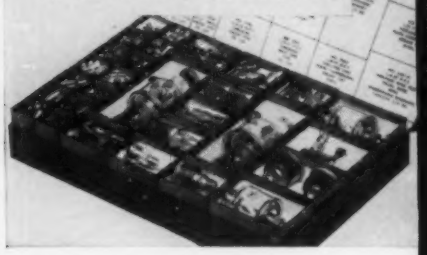

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Shoulder Drive

Style G — No. 505
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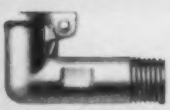
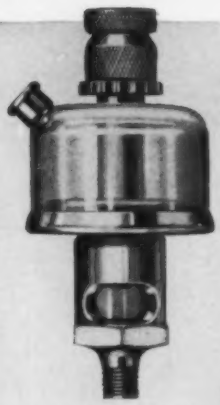
Style GB — No. 527
Ball Valve



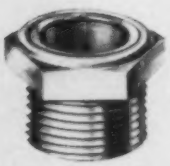
Style L — No. 1204
Brass Elbow (Threaded)

SIGHT GRAVITY FEED OILERS



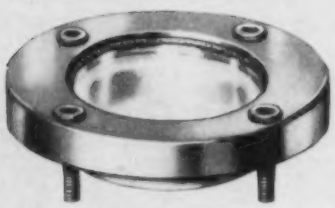
Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES



This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.

GEAR CASE GAUGES



Screw mounted, to set flush. Glass port is backed with white enameled reflector, to make oil level (in gear case or transmission) readily visible, even in dim light. Style CW — No. 4032.

SIGHT GAUGES

For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

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. . . then put American Spring Engineering Research Service to work for you!

WOULD you like the springs you now use to last longer? Would you like to cut their cost? Do you need design assistance on a difficult new spring application? *American Steel & Wire may be able to help you.*

We maintain complete spring testing facilities to help you solve any spring problem. Our spring engineering specialists can help you improve the *design* of your spring. We can help you determine the best possible *steel* to use. Then, we can completely check spring performance. We can simulate any spring operating condition and verify these recommendations in terms of improved service in your product.

Hundreds of companies have taken advantage of this service and have profited from it. Why don't you? Just write American Steel & Wire, 614 Superior Avenue, N. W., Cleveland 13, Ohio.

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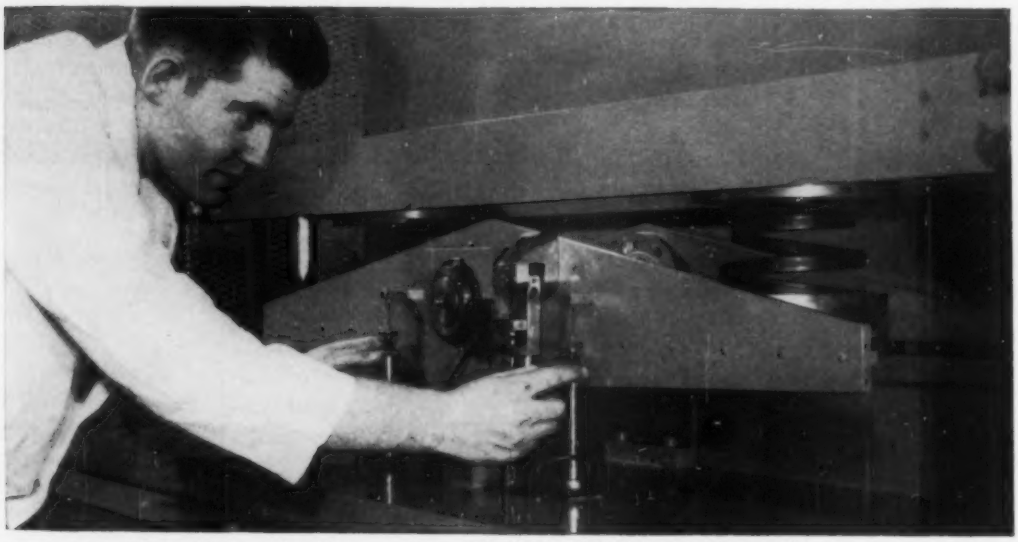
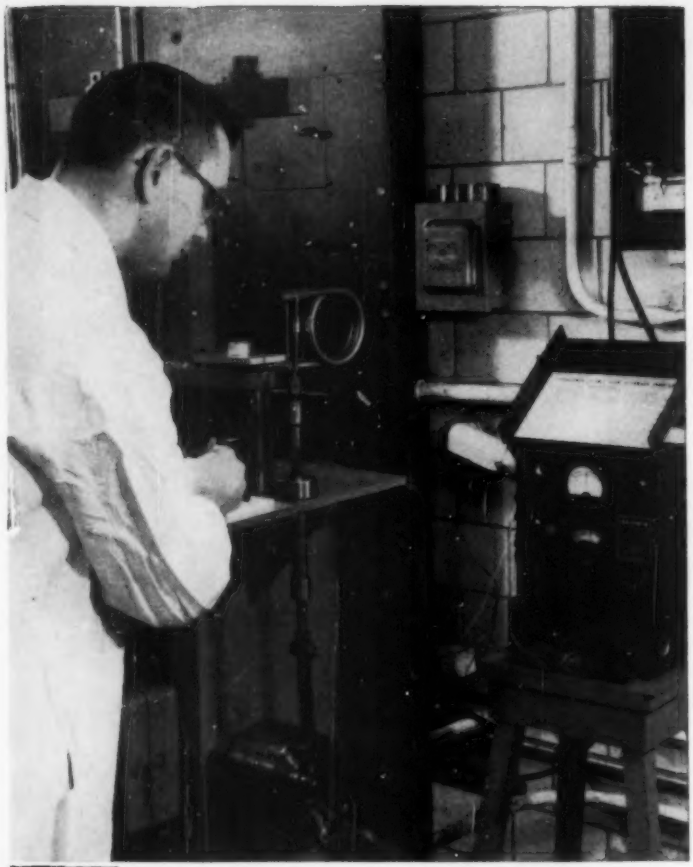


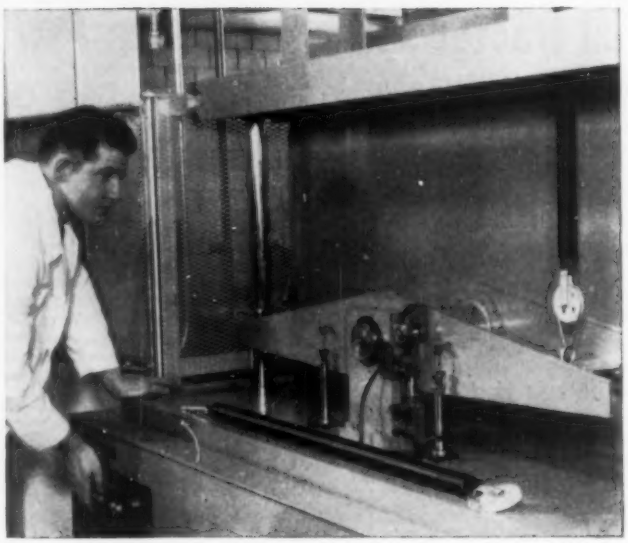
Heavy-Duty Clutch Springs Last Longer Now—Thanks to AS&W Spring Research!

The Lipe-Rollway Clutch Division, Lipe-Rollway Corporation, Syracuse, New York, asked AS&W Spring Engineering Research Service to determine if design change would lengthen the life of the flat wire compression springs used in their clutches. AS&W recommended design changes that greatly increased the spring life.



AS&W Spring Tests Make Possible New Design Rocking Chair!

40,000 springs—not one failure—American Steel & Wire helped Homecrest Company, Wadena, Minnesota, design a round wire helical torsion spring for an unusual new type of swivel rocking chair. To date, 20,000 of these chairs have been sold, but not one failure of the 40,000 springs has been reported.



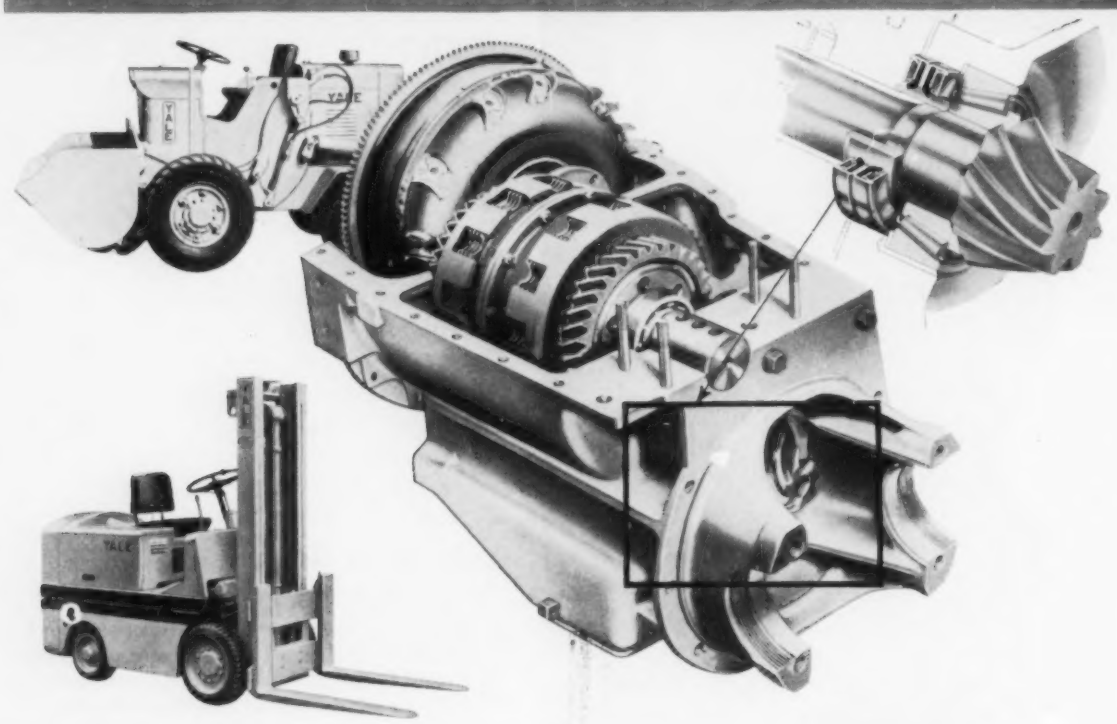
Design Change Increases Operating Life of Garage Door Springs!

The Steel Door Corporation, Birmingham, Mich., asked the AS&W Spring Engineering Research Service for a statistical evaluation of the fatigue life of this extension hook-type spring. As a result of the test, AS&W recommended a design change which has materially lengthened the operating life of the spring.

American Steel & Wire Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

NATIONAL OIL SEAL LOGBOOK



Oil seals "back-to-back" in torque transmission of Yale industrial tractor shovels

In both their new industrial tractor shovels and the famous KGA51 series lift trucks, Yale and Towne employ National Seals to separate transmission oil from differential lubricant. The seals are used at the pinion position of the unique, fully automatic Yale Torque Transmission. This assembly is basically a combination of a torque converter and a constant mesh transmission eliminating gear shifting.

Pinion sealing almost always presents unique demands on oil seals; performance must be of the highest order since most pinion seals are difficult to reach for replacement after assembly, and repairs to adjoining assemblies are costly.

To assure long-term, trouble-free performance for their customers, Yale and Towne install two 50,000 series National Seals at the pinion position. The seals are mounted back to back, one with its lip facing and retaining transmission oil; the other with its lip facing and retaining differential lubricant. Both seals used are standard-design National Micro-Torc leather seals with precision-made tension springs insuring optimum seating of lip on shaft.

National offers over 2,500 different standard-design oil seals — leather, synthetic rubber or felt. National Seal engineers are at your service—they're listed under Oil Seals in the Yellow Pages.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

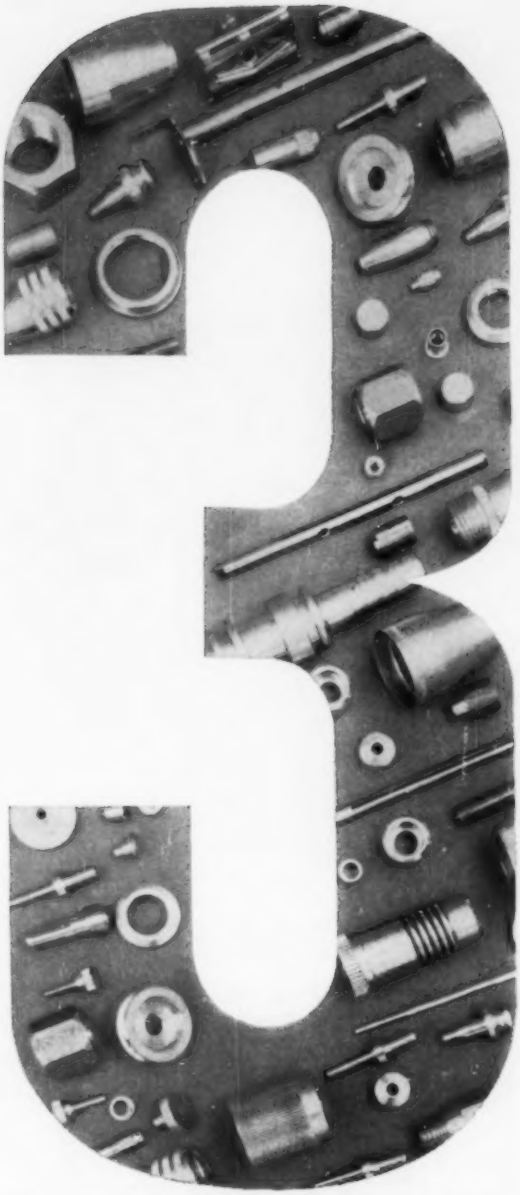
Micro-Torc*— National's "break-through" in leather seals

Micro-Torc Oil Seals, developed by and made only by National, have established new performance standards for leather seals. They absorb less power, run cooler and last longer than any leather seal made. Properly employed, they have *no measurable leakage* throughout service life.

Micro-Torc Oil Seals are produced by *coating*—not impregnating—chrome retanned leather with a dry lubricant in an elastomer binder. The result is a mechanically stable sealing member which does not leak oil *through* the leather, but does permit the unimpregnated central part of the leather to absorb oil for periods of momentary lubricant starvation.

See, feel the difference!

Micro-Torc sealing lips actually *look* and *feel* slicker, smoother — their cool-running, high-lubricity coating is plainly apparent to the touch. Ask your National Seal engineer to let you *feel the difference!*



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STARTS WITH
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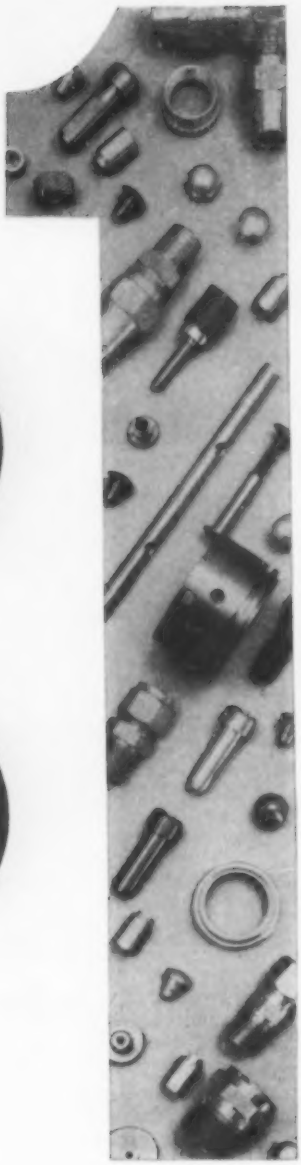

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Aluminum is versatile. Each of ALCOA's four screw machine stock alloys has significant advantages. Specify 2011-T3 for machinability; 6061-T6 for exceptional corrosion resistance and finishing characteristics; 2024-T4 for strength; and 2017-T4 for economy.

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New CUTLER-HAMMER Synchronous Timers Set the Pace in Industrial Control Timer Design and Performance

One minute timer: Adjustable in one second increments, 0 to 60 seconds.

Three minute timer: Adjustable in three second increments, 0 to 180 seconds.

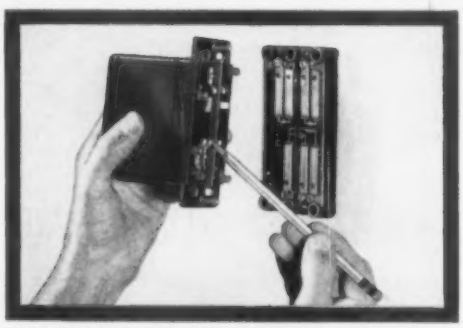
Five minute timer: Adjustable in five second intervals, 0 to 300 seconds.

All three timers are dimensionally identical and feature an exclusive combined terminal board and mounting base. This unique design provides more working-room during installation and on-the-job interchangeability of the timing units without disturbing the mounting base or wiring.

The timer dial reads directly in seconds and one glance shows the exact time delay setting. These timers are simple to set too. Just rotate the bronze pointer to the dial position indicating the precise elapsed time desired and the job is done . . . no approximations or tedious readjustments necessary.

The sweep-second pointer counts off the seconds during each timing cycle. Automatic reset returns the pointer to the start position after each cycle or if a power interruption occurs while in operation . . . no undertimed cycles possible.

These synchronous motor driven timers work better and last longer too. Dust, dirt, and atmospheric conditions can't interfere with the timing mechanism. For further information, write today for Bulletin 10336-Z-249. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.



The timing unit is removed from the mounting base during installation. Unique spring contacts mate with terminal strips . . . no inter-wiring necessary. The one, three, and five minute timing units are all the same size and easily interchangeable without disturbing mounting base or wiring.

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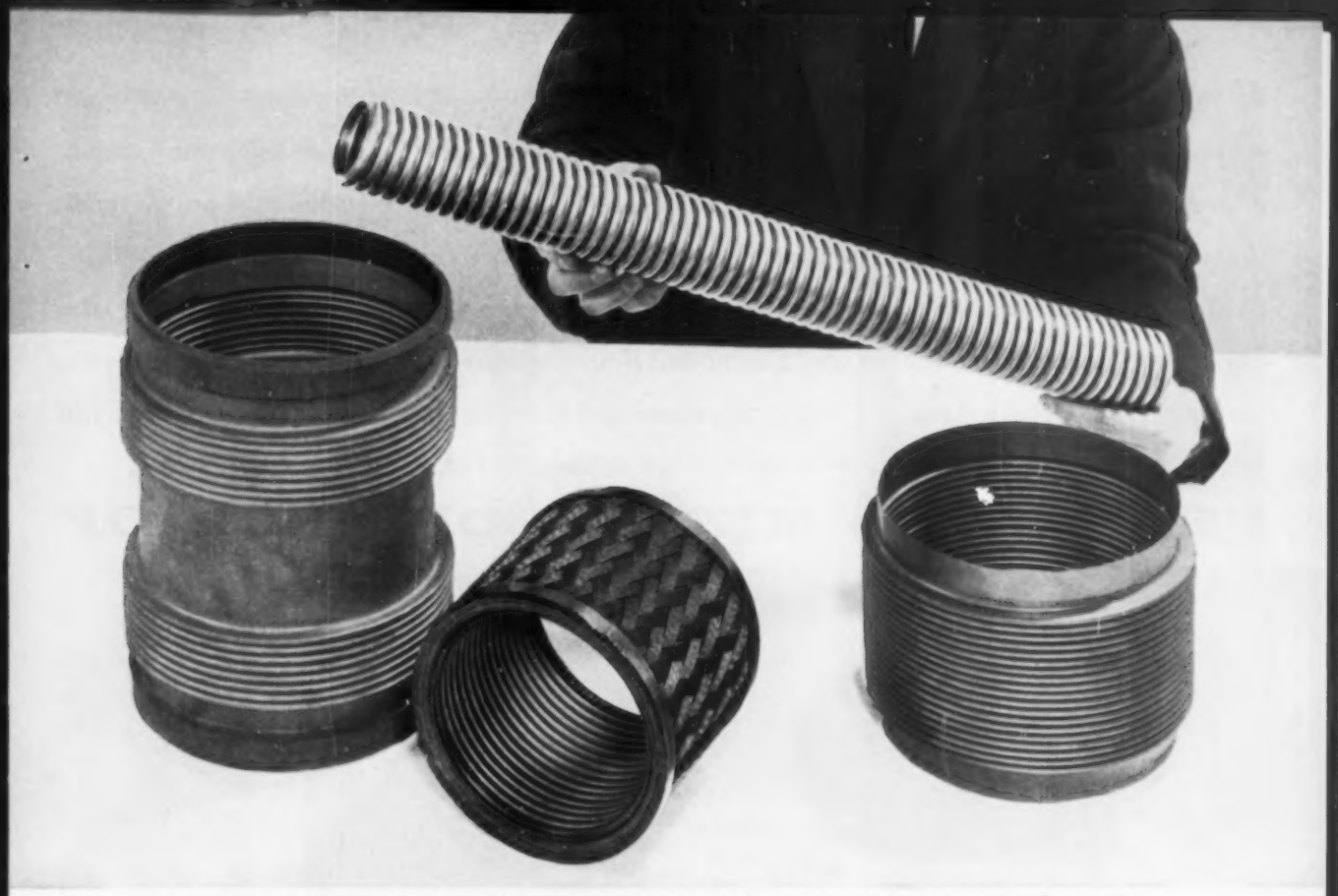

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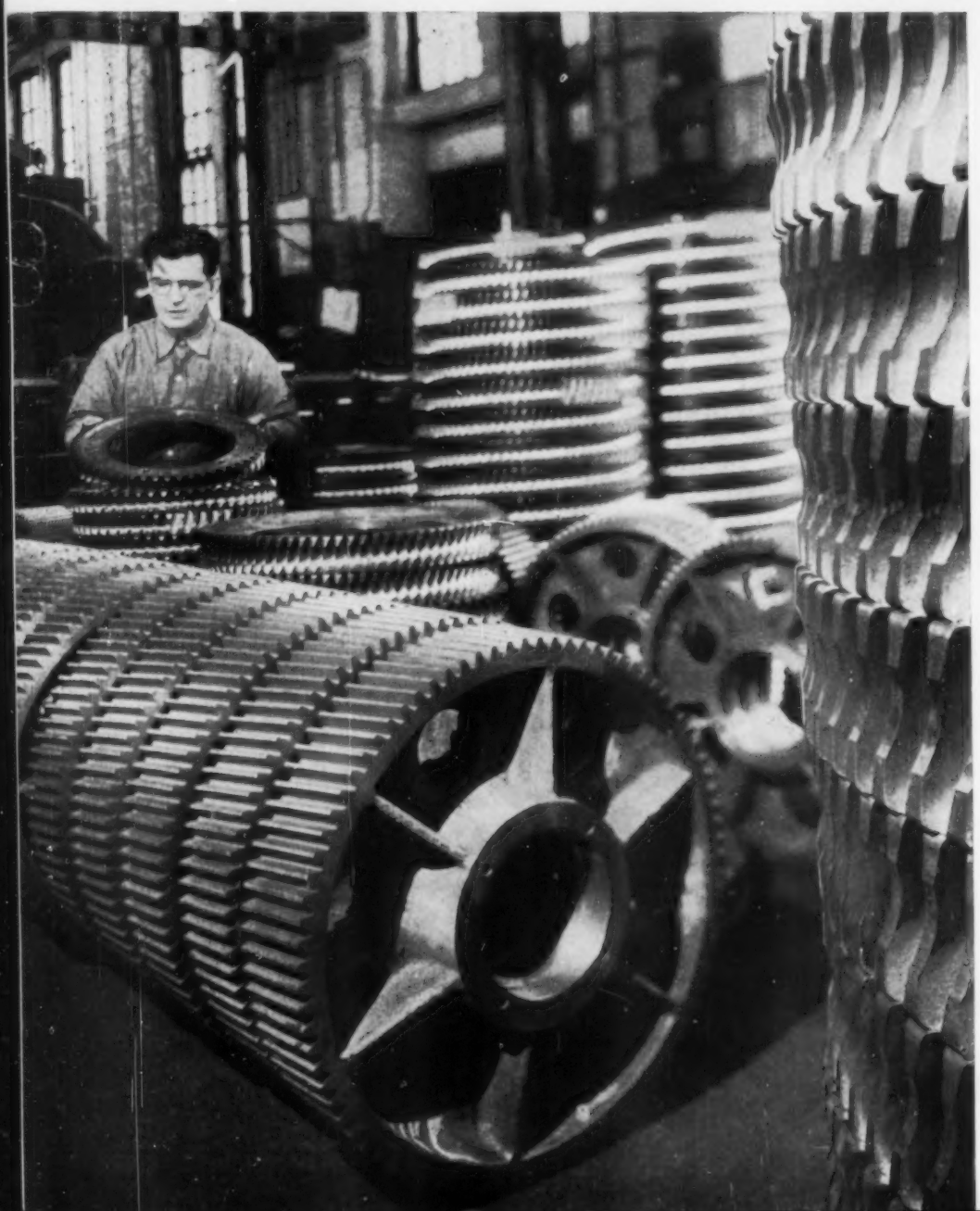

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Century Electric can help you get that right motor. Here's why: Century Electric sales engineers are motor experts. They know motors and drive problems inside and out because they think, sell and apply motors and nothing but motors. They can sit down with you and give you on-the-spot answers.

Over 10,000 types of motors are available from Century Electric. There is one for every type of application and for any kind of operating condition—dusty, corrosive, explosive or moist. Century Electric sales engineers will help you select the right one. They don't have to rely on only a few types, like this standard squirrel cage motor, to do everything.

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PERSPECTIVES

in design and development . . .

German Machine Tools: Still Climbing

In October, 1954 when PRODUCT ENGINEERING first studied the West German machine-tool industry following World War II, we found that country had completely regained its position in the field and had rung up a sales volume of $238 million in 1953. In four years, that figure has jumped to $445 million, and is expected to show a gain for 1958.

Exports, which held to about 50% of production in the early post-war years, slumped to 40% in 1955 and 1956, but sales so far this year have now moved back to the 50% point. Geographical distribution of exports has tended to return to the pattern of the 1930s except that North and South America have benefited at the expense of Europe. Total exports for the first half of 1958 are divided as follows: Europe, 63.3%; Asia, 18.6%; Latin America, 8.3%; North America, 5.4%; Africa, 2.4%; Australia, 2.0%. At the same time, exports to the US, after reaching a high of $17 million in 1952 have slipped behind machine-tool imports from the US.

Year	Production in $	Exports in $	Exports, % total	Exports to US in $	Imports from US in $
1954	262,338,000	129,225,000	49	6,837,000	5,548,000
1955	339,073,000	137,237,000	40	5,775,000	11,061,000
1956	412,351,000	166,352,000	40	7,453,000	10,160,000
1957	445,039,000	209,365,000	47	9,295,000	11,526,000

Engineering Changes

Technologically, the most important change from 1954 is a half step backwards: away from production-line automation on the US pattern, to automation of the individual machine. This means greater emphasis on universal machines with the necessary flexibility and longer utility, special fixtures, and automatic material loading and unloading at the individual machine. Major gainers will be medium and small manufacturers, and specialty firms which will become suppliers for the machine-tool makers.

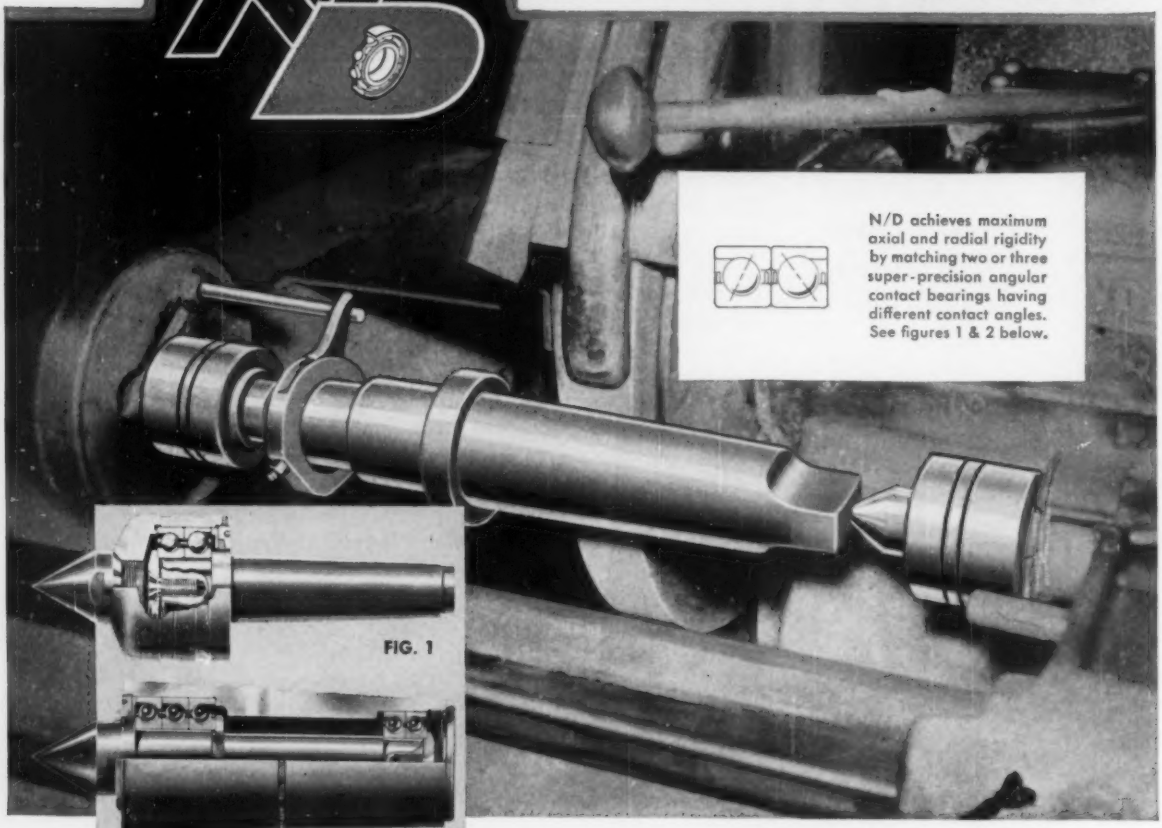
Control systems for German machine tools are changing as well. Hydraulic and electrical controls in combination are replacing the old-line straight hydraulic or pneumatic systems; and very slowly electronics is making itself felt. Recent showings have included: AEG punched tape control for a Gebrueder Heller milling machine; Matrawatt AG (of Nuremberg) controls for continuous-contour machines; digital coordinate-positioning device by Schwartzkopf AG of Berlin on automatic gage-producing machines, and Brown Boveri and Cie's pushbutton data-storage units for Schiess AG (of Duesseldorf) milling machines.

Ceramic cutters may work the same changes that high-speed steel did. With higher speeds and increased dynamics possible, the machines are being re-examined, and while the results still aren't enough to talk about, the Sixth European Machine Tool Exhibition in the Fall of 1959 is bound to show the fruit of the last few years of experimental work.

As of today, there are two mainsprings for a big push forward in West German machine-tool development: first, the automotive industry which, with the exception of Volkswagen and Opel, can and undoubtedly will help itself to a large dose of streamlining, modernization, cost-cutting; and second, an aircraft construction industry which will seriously get into business in the next 12 months—producing, under license, G-91 fighter and the Lockheed F-104.

—Paul Anderson

CASE HISTORIES


N/D achieves maximum axial and radial rigidity by matching two or three super-precision angular contact bearings having different contact angles. See figures 1 & 2 below.

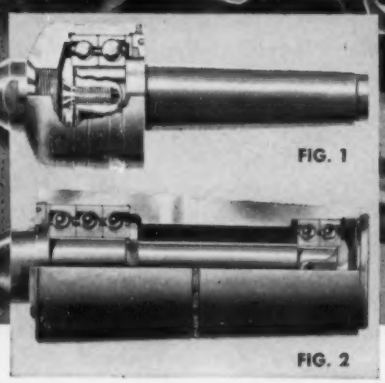


Photo: courtesy Ready Tool Company

Bearing Design Helps Live Center Maker Achieve Accuracy of .000050"!

CUSTOMER PROBLEM:

Live center maker requires bearing design that will help achieve . . . and maintain . . . live center accuracy of .000050", under combination radial and thrust loads.

SOLUTION:

After thorough evaluation of the problem, New Departure recommended N/D pre-loaded, duplex ball bearings. Extensive testing proved these super-precise ball bearings resisted combination radial and thrust loads with minimum deflection. The N/D ball bearings, with medium and high contact angles, are mounted duplex and positively clamped together to assure the optimum, pre-determined preload condition. As work expansion increases the thrust load, radial centering becomes more rigid and accuracy is precisely maintained . . . to less than .000050" total indicator run-out!

When you're working on new designs that call for high precision ball bearings, why not call on New Departure? New Departure's consistent precision is your assurance of the ultimate in accuracy for your design. For more information, call the New Departure Sales Engineer in your area or write Dept. P-12.

Available through United Motors System and its independent Bearing Distributors.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Product Engineering **HORIZONS**

December 22, 1958

Merry Christmas

Most of us recall with considerable nostalgia at this season our childhood belief in Santa Claus. Unless we're the progressive type, our children or grandchildren believe it now. Then, eventually, comes the wrench of learning the truth. But the pleasant memories of Santa Claus are always there, made more poignant by the grownup realization that it is a legend.

Much of our inner strength is built about such legends. **For example:**

Thousands of years ago, the Persians worshipped the sun-god Mithra, "the light of the world", who lived between Heaven and Hell. They held ceremonies in his honor every winter solstice—then Dec 25, now Dec 21, because of the change in the Roman calendar. The Greeks adopted this worship, called Mithraism, and from them in turn, the Romans took it.

Early Christians found Mithraism their strongest pagan rival. Finally, when they succeeded in stamping it out in the third century, compromises forced the adoption of certain of its customs and days of worship. Jesus' birth date was unknown, but legend placed it at the year-end (because Joseph and Mary were then in Bethlehem to pay annual taxes to the Romans) and a celebration with Jesus (replacing Mithra) as the "light of the world" was particularly appropriate. The then winter-solstice, Dec 25, was fixed upon. **In 534, Christ's Mass was recognized as a legal holy day.**

Early Germans added the Yule feast, the singing of carols, and the legend of Santa Claus. They, too, began to hang ornaments on the evergreen tree, which was simply the northern variation of the 12-branched (1 for each month) palm the Egyptians carried hundreds of years earlier in their winter-solstice worship of the god Isis. (One legend says also that the pine is the one tree that always points toward heaven.) Plum pudding, mince pie, and the exchanging of gifts were early medieval customs that were finally centered on Christmas Day. The Italians contributed their annual Jan 6 custom of hanging a stocking for gifts (only ashes, if the child had been naughty) from the fairy Befana, and England added the Yule log in 1577. Not until the latter half of the nineteenth century were Christmas cards introduced.

Every nation of Europe has made Christmas something peculiarly, quietly and simply its own. In England they burn the Yule log and gather 'round the punch bowl. In Norway and Sweden they hang paper streamers, let the children seek out their hidden gifts, and scatter grain for the birds. An Italian Christmas includes the revered "praesipio", and Spaniards go to midnight mass on the "noche buena."

Bavarian children cherish painted toys and gingerbread menageries. In the Tyrol they carve out nativity scenes and sing happy carols. In Holland they carry the great Star of Bethlehem on a pole through the streets. French children hunt lucky coins in the big Christmas cake and the little cakes with a sugared Christmas child on top. South of the Danube, the whole family feasts in a circle on the straw-strewn floor, then children sing to the cows for milk to bathe the newborn "little God". But in every country it is really a "holy day", a family assemblage in quiet observance of the birth of Christ.

So we see that Christmas means something to all men, regardless of nation or creed. Man rises above the animals in one important characteristic, spirituality, or his belief in a higher power, be it on the surface or deep down inside of him. My investigation of its origins only strengthened my conviction that Christmas is the day when man forgets his petty hates and fears, when he joins with all other men since time began in the ageless wish for happiness, "Peace on earth and good will toward men."

May that age-old hope be our Christmas wish to you.

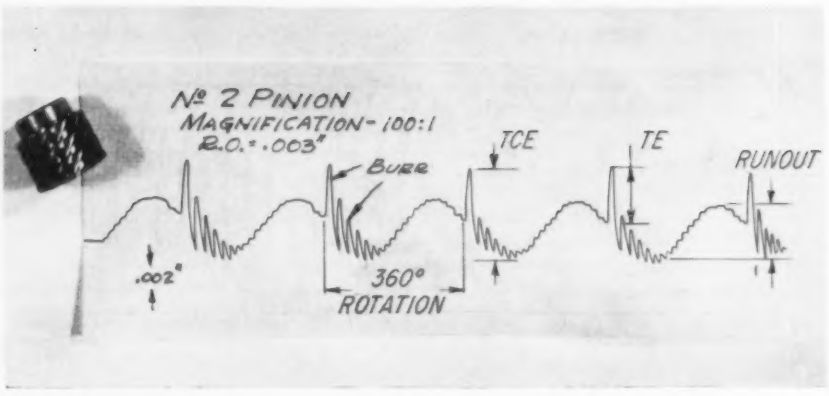
R. Langeman

NEW STANDARDS for GEARS SPAN WIDE RANGE of QUALITY

There is a pronounced demand for standards that will cover both "ultraprecise" gears and low-cost gears of commercial quality. True, the German gear industry has 15 classes in its quality range—but has not shown a clear-cut pattern in its divisions. By contrast, the author of this article has also established 15 classes—but with a logarithmic sequence resulting from detailed examination of thousands of gears.

Here, then, is presented for the first time an all-inclusive gear standard that can be applied immediately to spur and helical gear specifications—without conflicting with present AGMA standards. The author, who is chairman of the American Standards Association Subcommittee on Fine Pitch Gears, and member of three American Gear Manufacturers Association committees, invites comment from both engineers and manufacturers.

L D MARTIN, *Gear Consultant, Rochester, NY*



Composite check . . . on gear rotated five times gives data on total composite error (TCE), tooth-to-tooth composite error (TE), and runout. Gears are rotated in mesh with a master; trace on graph then shows variations in center-to-center distance.

The composite check for gear teeth is still the most popular method of controlling the quality of gears (*PE—Nov 1 '56, p 135*). Though it has some shortcomings and does not fully meet requirements when an exact knowledge of angular errors is essential, it is widely used for gears ranging from 6 to 200 diametral pitch in many applications ranging from the commercial to the military. There has been a recent trend, however, to call for "ultraprecision" gears in control and computer applications. The present composite check standards do not include specifications for such precise classes. Nor do they include sufficient specifications for gears at the other extreme—the low-cost commercial gears.

A Broader Standard

The new standard proposed by the author requires changing the present classes of gears very little, and does extend the range of both the ultraprecise and commercial gears. The standard is applicable to both spur and helical gears.

If the total permissible variations to center-to-center distance (generally referred to as the total composite error) for the seven present AGMA classes are plotted on log paper it will be seen that the classes follow closely a true logarithmic sequence, as charted on this page. The proposed new standard will extend the range logarithmically to 15 gear classes.

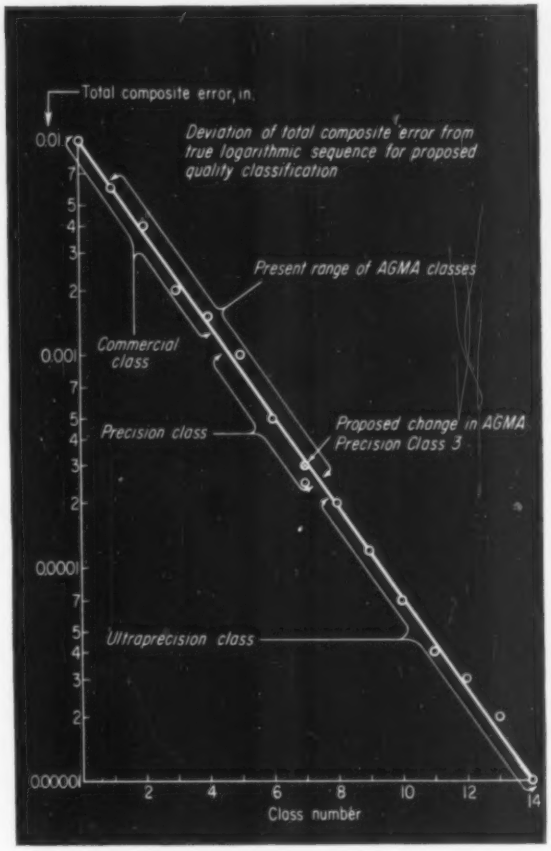
Of these classes, the crudest (0) will have a total composite error of 0.010 in. and the most accurate (14) will have a corresponding total error of 0.00001 in. By following an approximate logarithmic sequence, the tolerance is much broader, class to class, in the cruder quality area than in the highly accurate areas. This makes sense—it recognizes that as class numbers go up, it becomes harder to lift the quality from one level to another. Except for class 7, the present AGMA Fine Pitch Standards fall right in place with the proposed new classes.

Three groupings that cover the 15 gear classes in Table I are: Commercial, Precision, and Ultraprecision. Values for both total composite error (TCE) and tooth-to-tooth error (TE) are shown. The Ultraprecision groups will undoubtedly require an angular transmission check. When this is made, angular transmission tolerances may be either substituted for the composite check or added to it. Because angular tolerances will vary for each application, they are not listed and should be determined by mutual agreement between user and producer. This concept follows closely a caution note recently added to AGMA Standard 236.04, stating that the composite check does not fulfill the needs of certain types of instrument gearing, and angular transmission tolerances should be specified.

Development of Classes

The 15 classes were arrived at after studying the needs of industry for several years. This found that gears which are cut, stamped, die-cast, injection-molded and, more recently, rolled will fall well within the 0.010 TCE of class 0.

At other extreme is the Ultraprecision group, used largely for guidance systems. Here, angular transmission is of extreme importance—industry is currently limiting total index error to 4 or 5 seconds of arc, and will soon



WHAT IS A COMPOSITE CHECK?

When a gear is revolved in tight mesh with a hardened and ground master gear, any changes in center-to-center distance can be observed on a dial indicator or recorded on graph paper, and then compared with acceptable deviations as listed in one of the gear standards.

Such is the composite check. In a more primitive form, it is quite old. During the early days of World War II it was adopted as the quality yardstick for Fine Pitch Gears and its name, Rolling Check, was changed to Composite Check. The tooth-to-tooth composite error was formerly called "kickout" or tooth action. The AGMA (American Gear Manufacturers Association) Standard 236.01, Section 1, was the first organized attempt in this country to popularize and standardize this method of checking gears of pitches finer than 20 D.P. and is the one generally in use. The coarse-pitch gear industry also is generally adapting the composite check patterned after AGMA's Fine Pitch Standards.

At present two independent groups in this country, the American Standards Association Sectional Committee B6 on gearing, and the AGMA, are striving for a more comprehensive system. For its guide, AGMA has taken the German D.I.N. standard, which envisions 15 gear classes. The author's proposed standard also employs 15 classes—but makes use of a logarithmic sequence.

TABLE I

THE PROPOSED 15 GEAR CLASSES

SUGGESTED COLOR SCHEME	CLASSIFICATION		PROPOSED TCE ERROR	PRESENT TCE, AGMA 236.04	PROPOSED TE ERROR	PRESENT TE, AGMA 236.04	COMMENTS
		0	.010	None	.005	None	New class
GREEN	COMMERCIAL	1	.006	.006	.0032	.002	
		2	.004	.004	.0021	.0015	
		3	.002	.002	.0013	.001	
		4	.0015	.0015	.0008	.0007	These are the present AGMA classes—seven in all
AMBER	PRECISION	1	.001	.001	.0005	.0004	
		2	.0005	.0005	.0003	.0003	
		3	.0003	.00025	.0002	.0002	
RED	ULTRAPRECISION	1	.0002	None	.00014	None	New classes
		2	.00012		.00009		
		3	.00007		.00006		
		4	.00004		.00004		
		5	.00003		.00003		
		6	.00002		.00002		
		7	.00001		.00001		

require cutting this error to only one or two sec. The exact logarithmic sequence is shown in Table II. This sequence was rounded off, and it can be seen that the change creates no significant difference.

Tooth-to-tooth composite error was also derived from logarithmic sequences. This can be seen by dividing the exact log sequence, Table II, in half; then comparing with TE values in Table I. Present AGMA values are not far from the proposed ones.

Beyond class 12, (which is No. 5 in the Ultraprecision group) the TE begins deviating asymptotically toward zero. This is because, as a quality is improved, it becomes harder to spot and measure such error—and eventually the difference between error levels cannot be distinguished.

Specifying Size

In AGMA Standard 236.04, size is specified by a letter suffix following the class number, thus: Precision 2C or Commercial 1A. This suffix is intended to cover a pitch range and tolerance band. Class A tolerance means 0.004 to 0.006 in backlash in two mating gears of equal tooth thickness on nominal centers, and applies only to gears of 20 to 45 pitch. The same tolerance is not usuable for gears of 46 pitch and finer; there would be disproportion between standard tooth thickness and desired thickness. Teeth would become too pointed if backlash allowance were not based on a percentage of tooth thickness. While this AGMA approach seems simple, it is somewhat restrictive and has apparently outlived its usefulness. The need has grown for a simple yet reliable way to specify size—foolproof, yet flexible enough to let individual judgment have some say when considering the application.

The proposed size specifications are given as a plus-or-minus change from the standard pitch radius $N/2P$, where N is the number of teeth and P the diametral pitch. The value is expressed in tenths of thousandths.

For example, a 32-tooth gear has: 16 D. P.; pressure angle, 20°; pitch dia, 2 in.; nominal pitch radius, 1 in. Assume this gear is to have max tooth thickness, at the standard dia; that is, 0.002 to 0.003 in. less than standard thickness. This narrowing, Δt, is converted to a change in radius, ΔR, by dividing it by twice the tangent of 20°; thus

$$\Delta R = \frac{0.002}{2 \tan (20)} = 0.002747$$

The testing radius would then be from 0.002747 to 0.00412 in. less than 1.000 at the point of tightest engagement, or high point of runout.

The tolerance specification for such a gear made to Commercial Class 2 would be written:

$$\text{Commercial 2} \quad \begin{matrix} -28 \\ -41 \end{matrix}$$

This means the gear will have a total composite error not to exceed 0.006 in. and a testing radius which is 28

TABLE II

COMPARISON BETWEEN PROPOSED LOGARITHMIC, AND AGMA VALUES FOR TOTAL COMPOSITE ERROR

CLASS		EXACT LOGARITHMIC SEQUENCE	TCE, COMPUTED	TCE, ROUNDED OFF	CURRENT AGMA VALUES
COMMERCIAL	0	100,000	.010	.010	None
	1	61,000	.00615	.006	.006
	2	37,000	.00373	.004	.004
	3	22,500	.00227	.002	.002
	2	14,000	.00138	.0015	.0015
PRECISION	1	8500	.000847	.001	.001
	2	5200	.000521	.0005	.0005
	3	3150	.000317	.0003	.00025
ULTRAPRECISION	1	1920	.000192	.0002	
	2	1180	.000117	.00012	
	3	720	.0000714	.00007	
	4	440	.0000444	.00004	None
	5	268	.0000270	.00003	
	6	162	.0000163	.00002	
	7	100	.0000100	.00001	

to 41 tenths of thousandths smaller than the 1.000 standard pitch radius as measured at the point of tightest engagement. For each 0.001 in. change in testing radius plus or minus, the tooth thickness change is as follows: for 14½° pressure angle, 0.0005; for 20°, 0.0007; and for 25°, 0.00095. This change in tooth thickness may be put in terms of effective tooth-thickness change due to runout.

Method Avoids Confusion

This concept of specifying size is broad and avoids confusion when specifying size of nonstandard gears and pinions. For example, consider this case: an enlarged 12-tooth pinion, 20 diametral pitch, 20° pressure angle, made in accordance with AGMA standards. This pinion would have a standard pitch radius of 0.300 in. and an apparently enlarged pitch radius of 0.3149. The pinion is cut oversize 0.0149 on radius; in other words, the center distance between the work and generating tool is increased by this amount. Assuming no allowance for backlash, and assuming a quality class of Commercial 3, the complete specifications would be Commercial 3 + 149, meaning that the testing radius is 149 tenths of thousandths greater than the standard 0.3000 pitch radius. The plus sign immediately earmarks thas pinion as an enlarged pinion.

When allowance for backlash is desired, the same procedure is followed: The figure +149 would be reduced. If, on the other hand, the need was for a reduced gear mating, on standard centers, with the above pinion, the plus sign would merely change to minus. Such a gear would have a minimum of 27 teeth. The very fact that the allowance for backlash is excessive as indicated by the 0.0149 in.-reduction earmarks the gear as a reduced, short-addendum gear. Ordinary backlash allowance would have indicated a figure in the neighborhood of 10 to 30 tenths of thousandths and have been well inside of the 149 figure.

When nonstandard gears are checked with standard masters such as long-addendum pinions or short-addendum gears, the change in center distance is not proportional to the change in tooth thickness, as would be the case if the gears were checked with a rack.

This is because the operating pressure angle between the master and work changes; whereas, in a rack, the operating and standard pressure angles are always equal regardless of tooth proportions.

To calculate the required center-distance correction when nonstandard gears are checked with a standard master, or when standard gears and pinions are checked with a nonstandard master, use these formulas:

$$C = \frac{N_M + N_G}{2P} \qquad C_T = C\left(\frac{\cos\phi}{\cos\phi_T}\right)$$

$$\text{INV}\ \phi_T = \frac{N_M\,(T_M + T_G) - \pi D_M}{D_M\,(N_M + N_G)} + \text{INV}\ \phi$$

Where

C = Standard center distance, in.
C_T = Testing center distance, in.
D_M = Standard pitch diameter of master gear
INV = Involute of an angle
N_g = Number of teeth in work gear
N_M = Number of teeth in master gear
ϕ_T = Operating-pressure angle at testing center distance, deg
T_G = Circular tooth thickness of work gear on standard pitch dia, in.
T_M = Circular tooth thickness of master gear on standard pitch dia, in.
ϕ = Pressure angle at standard pitch dia, deg

This new yardstick of quality control for gears has been reviewed by a selected group of people who have expressed favorable opinions and the hope that it will receive general acceptance. It is also hoped that the readers of this magazine will express their critical opinions of this new approach to gear-quality control. Comments are invited.

REPRINT of this article can be obtained for your reference file by checking No. E56 on one of the Reader Service cards found in this issue. For other reprints available see "Current Reprints" listing in this issue on page 94.

progress report:

MANGANESE joins ALUMINUM to give STRONG STAINLESS

Technology has long been intrigued by the possibility of alloying aluminum and iron to give a lightweight, "poor man's" stainless steel. But the combination was too brittle for cold-working. Now a Navy-sponsored project introduces this completely austenitic Al-Mn-C steel that supplies ductility for forming, and strength at high temperatures. Here are first data on the promising candidate.

J L HAM, *Research Associate*
R E CAIRNS JR, *Research Metallurgist*
National Research Corp

What the US Navy wanted was a stainless steel that depends on aluminum for resistance to oxidation and corrosion. Navy's main purpose was strategic: Aluminum is plentiful; chromium and nickel might be hard to get for stainless in time of war. Also, the relative cheapness of aluminum could lead to a "poor man's stainless."

From the resulting research program has come a family of alloys including a candidate that shows particular promise. This alloy containing 10.2% aluminum, backed up by manganese and carbon to make it austenitic, can be strengthened to a remarkable degree by strain-aging.

In this the alloy marks a big step forward. Using aluminum to reduce weight and cost of stainless is not in itself a new idea. But like chromium alone, aluminum alone keeps the steel ferritic. This means loss of its mechanical properties above 1200 F. Such aluminum-irons also lack ductility—though readily forged and hot-rolled, they cannot be cold-formed by rolling or stamping. An austenitic stainless would get around such problems, hence the program sponsored by the Materials Branch of Navy's Bureau of Aeronautics.

The candidate turned up by this research has several other valuable properties besides being strain aging, but it also represents a certain amount of compromise. In getting increased high-temperature strength this new austenitic steel lost some resistance to oxidation and probably some of its corrosion resistance as well. But through the ideal—a superstrong, oxidation-resistant stainless at the cost of carbon steel—remains in the future, the research has brought it nearer to reality.

Besides its aluminum content, the new alloy has 34.4% manganese and 0.76% carbon. It has these properties:

Light weight—all three of the additional elements, Al, Mn and C, are lighter than steel. Steel from this family is approximately 15% lighter than carbon steel and 18-8 stainless, and over 20 to 25% lighter than those heavyweights, the nickel- and cobalt-base superalloys. Because this light weight is also accompanied by strain-aging characteristics, the Al-Mn alloys promise strength-weight ratios higher than most of today's metals.

High strength throughout the useful range of room temperature to above 1200 F. A comparison is given in Table 1 of the Al-Mn stainless with carbon steel and two austenitic stainless steels. But this comparison of tensile properties in the annealed condition does not show the new stainless to its true potential. It also gains strength from work-hardening and strain-aging.

Table I—Mechanical Properties of Steel vs Stainless

Alloy	Ultimate Tensile Strength, psi	Yield Strength, psi	Elong-ation, %	Reduction in area, %
	at room temperature			
Carbon steel	60,000	39,000	35	66
347 Stainless	91,000	39,500	50	71
304 Stainless	85,000	34,000	63	76
10 Al-34 Mn	109,000	55,000	73	71
	at 1200 F			
Carbon Steel	15,200	9,200	63	91
347 Stainless	48,000	26,000	45	71
304 Stainless	41,200	12,000	39	55
10 Al-34 Mn	60,400	40,500	34	32

Table II—Cold-working Increases Hardness of Stainless Steels

	10 Al-34.4 Mn	18 Cr—8 Ni (302 Stainless)
Red. Area, %	Hardness, R_A	Hardness, R_A
0	53	54
10	64	61
20	66	65
40	70	68
60	72*	69
80	74*	

* May be raised as much as 7–8 points R_A by strain aging 1 hr at 1290 F

Strain-aging. Added hardness from an aging heat treatment after cold-working gives high strength after forming. Hardness data indicate that the degree of strengthening obtained by strain-aging may be considerably greater than that possible in existing age-hardenable austenitic steels. The 10 Al-34 Mn alloy when worked above 60% shows an increase of 7 to 8 points R_A upon aging. If the normal data for strength vs hardness of 18-8 stainless were used, then the extra hardness at this level would give the new alloy a tensile strength approaching 250,000 psi—not attainable in any austenitic stainless steel of the Cr-Ni type. These normally soften and stress-relieve if heated after cold-working. Further, this strain-aging has the advantage of giving the added hardness to already formed parts at a relatively low aging temperature (about 1200 to 1300 F).

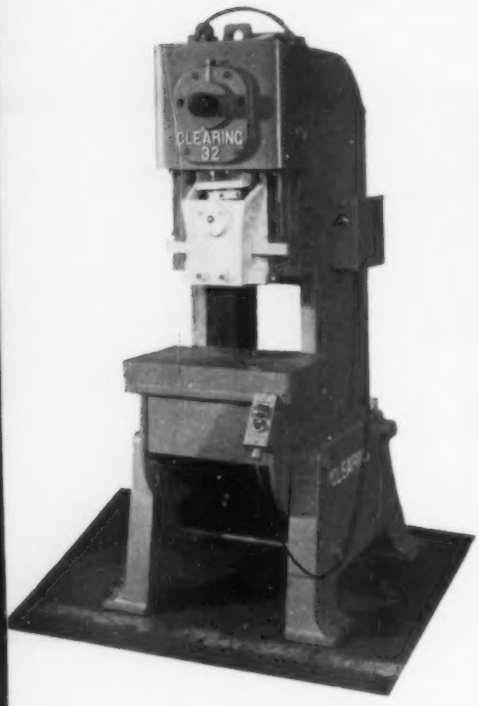
Oxidation resistance. Although less than for the Cr-Ni stainless and straight aluminum-irons, the Al-Mn alloy has adequate properties up to 1500 F. In a 100-hour test, 0.0065 in. on the surface was oxidized. (Other members of this family have slower rates of oxidation.) In the range of 1200 to 1300 F where its strain-aged strength is highest, the oxidation penetration is even lower.

Ductility at room temperature is roughly equivalent to that of 18-8 stainless and permits cold-forming by rolling, swaging, bending, stamping and drawing. Because it work-hardens readily, the new alloy would probably have to be annealed frequently during intricate fabricating procedures. However, work-hardening is regarded by some missile experts as the most important single property for short-time high-temperature strength. Although the higher yield strength means that somewhat heavier working forces would be needed for cold-forming, in most cases normal equipment for cold-working stainless steel can be used. Machinability is similar to that of 304 stainless.

EDITOR'S NOTE: The above progress report is latest in the succession of articles covering new materials and protective coatings that help design for high-temperature applications. For another recent stainless development, this one concerning experimental alloys containing aluminum and chromium, see *PE—Sep 1 '58, p 20*. Also, to place the new stainless in perspective, consult these articles:

Materials—"New Superalloy Bids for Hot Jobs," July 21 '58, p 76; facts and curves compare Rene 41 with other alloys from 1200 to 1800 F. "High-temperature Stainless," Apr '57, p 135; compares mechanical properties and structural stability of 8 candidates for between 600 and 1400 F. "Titanium Carbide," Nov 11 '57, p 84; compares mechanical and physical properties of TiC with superalloys. "Nitride-bonded Silicon Carbide," Feb '57, p 135; a specially bonded ceramic with improved hot strength and resistance to abrasion and corrosion. "Metals at Elevated Temperatures," Oct '56, p 186; discusses basic design questions for materials at elevated temperatures. "High-temperature Materials," Sep '56, p 186; reviews early developments, alloy systems used, properties required, methods of evaluation, and trends.

Protective coatings—"High-temperature Coatings," Jan 20 '58; for high-temperature resistance to corrosion and erosion. "Hot-dipped Aluminum Coatings," Oct 28 '57; they allow substituting cheaper base metals, cut fabricating costs and reduce maintenance.



Packaged Punch for Presses

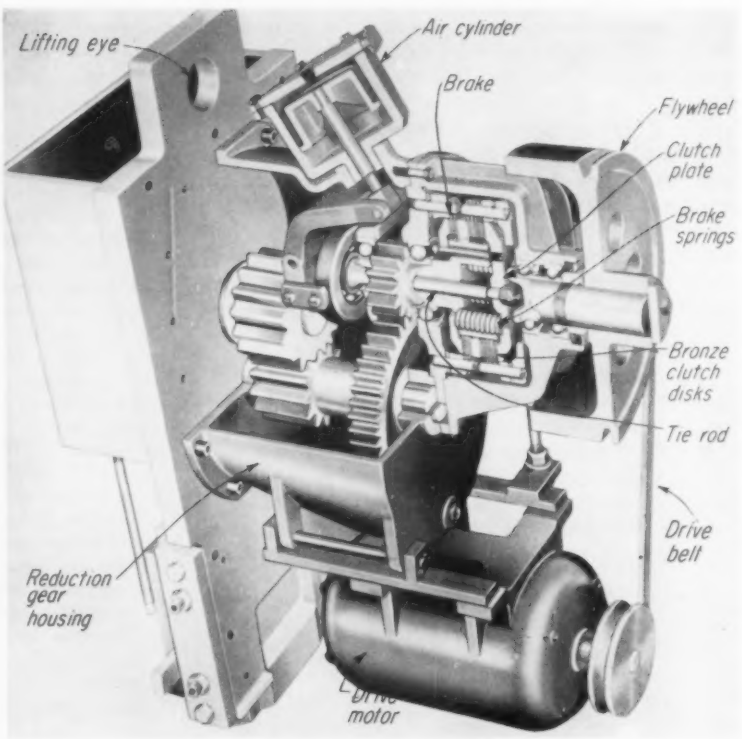
Easily removed drive packages work this company's standard presses and can be adapted to custom frames.

All working components of the press are contained in a drive package interchangeable with other presses of equal tonnage. But the subassembly—air-friction clutch, reduction gearing and clutch-brake housing—is interchangeable among all these Torq-Pac O.B.I. (Open Back Inclinable) presses regardless of tonnage. They are available in 22, 32 and 45-ton models, produced by Clearing Machine Corp, Div of U. S. Industries, Chicago.

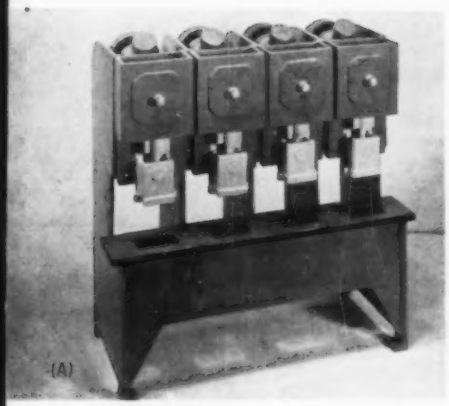
Removable package . . . consists of drive motor, flywheel, air-friction clutch-brake unit, reduction gearing, eccentric shaft, connection rod, slide and gibs. Power flow is by V-belt from motor to flywheel, and through clutch-brake unit to reduction gearing that drives eccentric shaft and slide.

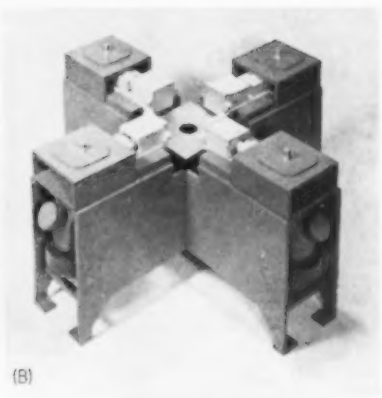
Multiplate clutch-brake assembly has alternate disks of steel and sintered bronze running in oil. Upon engagement, oil is squeezed from between the disks. Actually the oil begins to transmit the load prior to metal-to-metal contact between friction disks and driving plates. This substantially reduces wear upon the disk members. The sintered bronze disks are standard automotive transmission components.

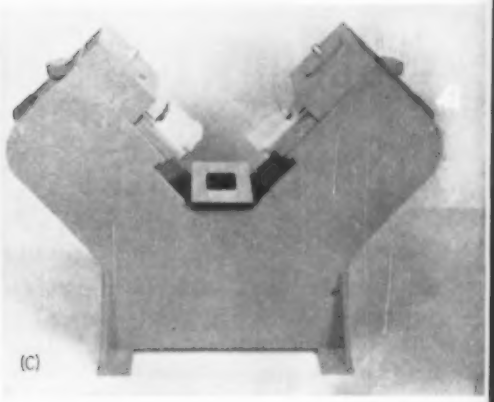
Clutch and brake are mechanically interlocked to prevent simultaneous engagement. Brake springs keep the brake engaged when the solenoid-operated air cylinder is not activated. On activation it pulls the tierod and clutch plate forward. This compresses the brake springs —releasing the brake and engaging the clutch. When air is exhausted from the air cylinder, spring pressure disengages clutch and engages brake. In case of air or electrical failure, spring pressure engages the brake and stops the press.



IN NEW PRODUCTS





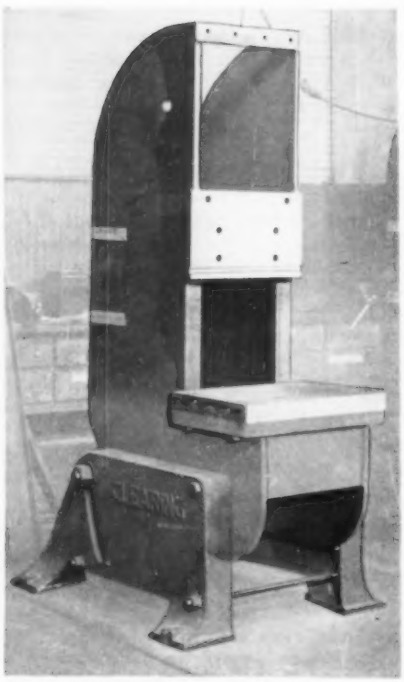


Choice of setups . . .
for multiple operations is shown here—drive packages can be mounted in any position. Synchronization of presses is simplified by solenoid actuation of air cylinder . . . .

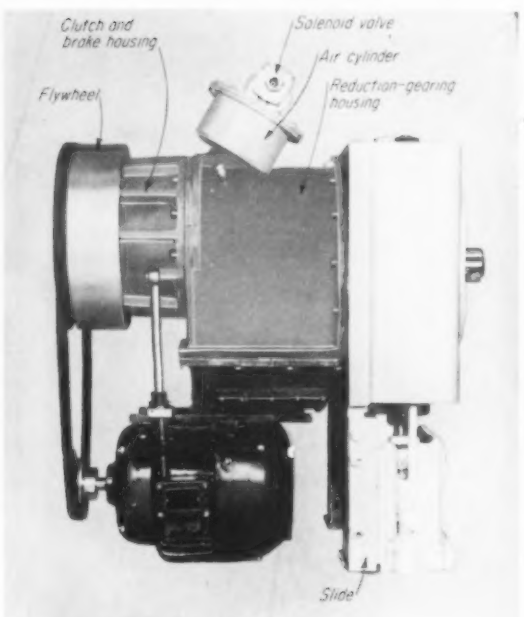
(A)—Four press packages in line provide successive operations on one piece of stock for volume production. Unit can be fed from strip or roll stock; or automated transfer equipment can be added.

(B)—Four press packages working at right angles provide four-way forging or stamping of four sides of sheet metal housings.

(C)—Two press packages, each mounted at 45° from the vertical, can work two sides of sheet metal workpiece or forging simultaneously.



Basic components . . .
of Clearing's standard press are the drive assembly, press frame and base. Frame is welded into single unit that provides mounting pads for the drive assembly and bolster plate. Drive assembly goes in as a unit between frame sides and is retained by six bolts. Completely interchangeable, drive units can be purchased separately as spares or for mounting in custom frames as shown at top of page.



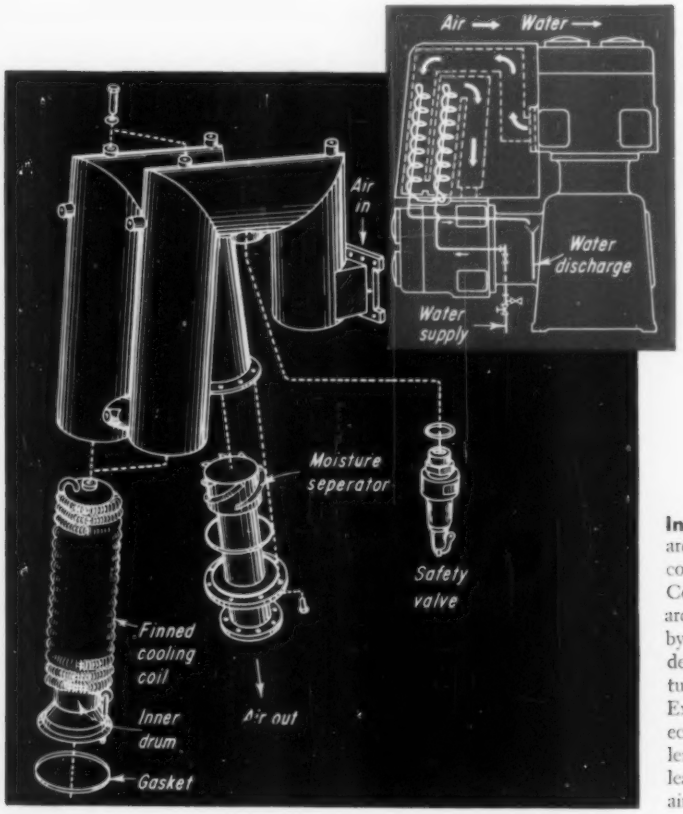
Coiling the Cooler Saves Water

Compact compressor also occupies less space than comparable models. Combination lubrication system uses oil from crankcase for lubrication of cylinders as well as moving parts.

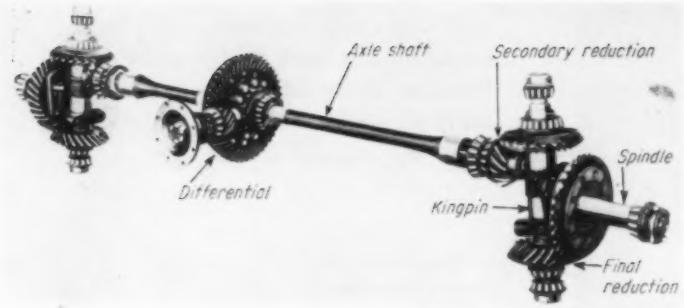
Clean-looking exterior results from placing most air, oil and water lines in major castings or under covers. Also, countersunk socket head-screws and rounded castings simplify cleaning. The cooling-water discharge can be connected to supply plant heat. This ER6 2-stage compressor produces 1140 cu ft/min at 100 psi with a 225-hp power source. Produced by Atlas Copco AB, Stockholm 1, Sweden.

Two-stage compressor . . .
has cylinders mounted at 90° to each other on cast crankcase. Low-pressure vertical cylinder and high-pressure horizontal cylinder are fitted with double-acting disk pistons. After first-stage compression, air goes through intercooler to the HP cylinder for compression to final working pressure.

Both cylinders are supplied by a force-feed lubricator fitted to the main lubrication pump. The preset lubricator delivers four drops of oil a minute to the HP cylinder and 8 drops a minute to the LP cylinder. The drops are visible in a sight glass in the lubricator housing—first, one drop is delivered to the HP cylinder; four seconds later, two drops go to the LP cylinder. This procedure is repeated approximately four times a minute.



Intercooler and moisture trap . . .
are housed inside large-diameter steel tubing that connects low-pressure and high-pressure cylinders. Cooling water passes through finned pipe, coiled around inner drums. Cooling coils are retained by single bolt at top of unit. Air from LP cylinder passes between inner drums and outer steel tube in space occupied by finned pipe coils. Excellent heat transfer and improved water economy is achieved by large fin area and turbulence caused by restricted air passage. After leaving intercooler, water condensed out of the air is removed by a moisture trap.

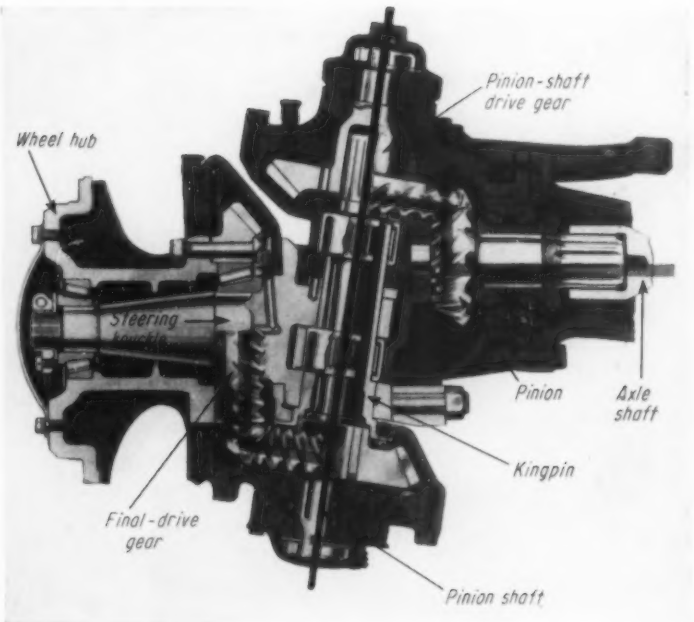


Power train . . .
includes 3-step speed reduction between drive shaft and wheels. Primary reduction is at differential and inboard end of axle shaft; secondary reduction is through gears above kingpin; final reduction is through gears below kingpin. Final-drive gear is bolted to hub on which brake drum and wheel are mounted.

Gears Provide Knuckle Power

Making gears do all the work of transmitting power to this truck's front-wheel drive eliminated universal joint from steering knuckles but presented a problem—solved by running the final-drive shaft through hollow kingpins.

The front-wheel-drive mechanism is fully enclosed for protection against dirt and water; uses oil lubrication for main carrier and axle ends. FAS 491 front drive is produced by Mack Trucks Inc, Plainfield, NJ, and used in its Model B-8136SX 6-wheel-drive truck for off-the road applications.



Steering knuckle . . .
pivots for steering action on the hollow kingpin. Wheel hub and final-drive gear are bolted together and run on tapered roller bearings mounted on steering-knuckle spindle. Final-drive gear is driven by pinion shaft running through hollow kingpin. Upper end of pinion shaft is splined to pinion-shaft drive gear driven by pinion connected to axle shaft. All gears are spiral-bevel-mounted in roller bearings; kingpin pivots in two needle bearings, has friction-type thrust bearing.

Colored line follows path of power flow from axle shaft to final-drive gear. Heavy black line is centerline of kingpin; indicates center of rotation of steering knuckle. Kingpin swivels on friction bearing and is aligned by two needle bearings.

PLASTICS:

WHERE VACUUM

It's also called thermoforming because it includes such variations as air-stretching and match-plate forming. It can make deeper parts, more complex designs. Here's latest on what the process will do.

RONALD L DAGGETT
Professor of Mechanical Engineering, University of Wisconsin

THIS NEW WAY DOES IT IN 4 STEPS

1 Sheet is loaded into clamping frame

2 Air from below stretches heated sheet

3 Hot plunger shapes plastic

4 Formed part is ready for removal

Variations on Basic Method

Vacuum forming has been modernized to include: automatic machines that feed from continuous rolls of sheet plastic; combinations that use air to stretch the part, and a plug-type plunger to make deeper draws and more uniform parts; match-plate molding that shapes with male and female dies; and snapback forming—preforms in a female mold, then finishes with a male die.

These variations on the process give new opportunity to design; for example, they have made possible such new products as:

- Skin packaging—provides the protective coating of thin plastic films in a sales-appeal container.
- Blisters or bubbles—give "see-through" structural shapes for enclosure or housings.
- Decorated and textured plastic sheet—imitate woodgrain, leather cloth, marble; add structural stiffness; also good for lettering instructions, labels, nameplates.
- Flexible coverings—give impact-absorbing crash pads for cars and other mobile equipment.
- Low-cost expendable parts for caps and covers.

FORMING STANDS TODAY

The picture sequence on the opposite page shows that turning plastics into parts by the old vacuum-forming method need no longer depend on suction alone. The ram pressure of air, given by a descending plunger, makes it possible to get a deeper draw and sharper corners. And air in the reverse direction keeps the plastic from sticking to top rim of the mold. Then, having delivered its air pressure, the plug goes up and the shaped part is ready for removal.

There are now so many other variations of the method that it is increasingly being called thermoforming. This allows for the decreasing importance of suction and the fact that, in each case, the material is a thermoplastic–formed after heat has softened it.

Money-saving is the big attraction of this process. For example, these features account for the cheapness of parts, such as enclosures and liners, made by the basic method:

- It shapes an inexpensive material–thermoplastic sheet stock.
- Tooling costs are low–only the male or female side of a mold is used, and can be made of cheap wood or plastic. For long production runs, tools are aluminum.
- The tooling can be changed easily, allowing flexibility in design.
- Decoration can be "built-in" by preprinting the stock before forming.

There are limitations too–forming can be on only one side of the part; depth-to-diameter ratio cannot exceed 1:1½. But in general, the method provides a good way to produce cheap, large, thin-walled parts.

The Basic Method

Thermoplastic sheet stock, clamped around the edge, is heated to formable limpness and draped over the mold. Vacuum is now pulled through holes in the mold. This draws the sheet against the mold; also chills the plastic, setting it into shape. After removal from the mold, unwanted edges are trimmed off, holes are punched, and other attachments added.

Although the common vacuum-formed shapes are relatively simple–essentially in one dimension and with only minor forming–this process can form structural parts up to ¼ in. thick, with depths of draw up to 1½ times the diameter. So, for best results with more complex parts,

COMPARISON OF SHEET PLASTICS FOR VACUUM FORMING

MATERIAL	Typical Thickness, in.	Cost, 0.020 thickness, $/M sq in.	Properties				Appearance*	Heating Time,** sec/mil thickness
			Sp Gr	Elongation, %	Flex. Modulus, psi x 10^5	Impact Strength, ft-lb/in. at 73 F		
STYRENE								
MODIFIED	0.020–0.125	0.55	1.05	15–60	2.5–3.3	0.7–6.0	T, O	0.35
BLENDS	0.020–0.125	——	1.12	50	1.8–2.2	4.0–8.0	T, O	0.37
ACRYLIC	0.080–0.187	1.75	1.19	2–4	4.25	0.4–0.5	C, T. O	0.40
VINYLS								
COPOLYMERS AND PVC	0.005–0.125	0.65	1.35–1.45	5–15	4–5	0.8–14.0	C, T, O	0.35–0.40
PLASTICIZED (flexible)	——	——	——	200–400	——	——	T, O	——
CELLULOSICS								
ACETATES (cast)	0.005–0.020	0.75	1.3	30–40	1.2–2.0	1.0–3.0	C, T, O	0.40
(extruded)	0.005–0.125							
BUTYRATE	0.005–0.125	0.80	1.2	50–60	1.2–1.4	1.8–2.4	C, T O	0.45
POLYETHYLENES								
BRANCHED (standard density)	0.020–0.125	0.38	0.92	500–650	0.3	No break	T, O	1.00
LINEAR	0.005–0.125	0.45	0.94–0.95	150–300	——	1. –5.0	T, O	1.00

*C = clear T = translucent, O = opaque

** With heater at 1100 F, 5 in. from sheet

and to take full advantage of vacuum forming's inherent high speed, these basics should be followed:

Maximum part size is limited only by size of large stock. Present machines can handle sheet up to 5 x 9 ft and even larger sizes can be made with simple tooling. Minimum sizes are limited by minimums of the radii.

Depth of draw for simple vacuum forming should not normally exceed ¾ the diameter, but draws up to 1 D can be had with some sacrifice in wall uniformity. With air stretching and assistance from a plunger, uniform wall thickness in draws up to 1½ D is not uncommon.

Draft required by female molds is a minimum of ½° because the part, on cooling, shrinks away from the mold. Male mold requires a minimum of 1° because the formed plastic shrinks around the mold. These molds are usually simpler to make and therefore lower in cost.

Minimum radii should exceed twice the thickness of the sheet. Where smaller radii are used, thick stock—⅛ to ¼ in.—will not develop true corners from vacuum alone.

Undercuts or reentry angles in general are undesirable because they complicate tooling. But thin flexible materials, if the undercuts are designed with large radii, can sometimes be stripped off the mold without special tooling such as retractable lugs or loose pieces.

Inserts add rigidity but cannot pass through the sheet (forming relies on a continuous sheet to retain the vacuum). Whether to choose wood, Masonite, or metal for the insert material, depends on the plastic and shape of the part. When heavy parts are formed around rigid inserts, relative expansion should be close enough so the shrinking plastic will not crack, or loosen the insert.

Rigidity of these plastic parts is determined by the flexural modulus and structural shape. Often, structural stiffening from ribs, corrugations, or beads will permit using thinner stock. Stiffness can also be added to liners by backing them with foam. This also gives heat-insulation.

Secondary steps, especially hand-finishing operations, should be kept to a minimum. Instead of sawing or drilling, these can be combined into one blanking step.

Allowable thickness of a part is difficult to determine when it is not uniform, but a rough evaluation can be made from this formula:

$$\text{thickness (part average)} = \frac{\text{thickness (sheet)} \times \text{area (inside clamp)}}{\text{Total area of part}}$$

EDITOR'S NOTE: Other articles on forming and designing plastics include: "Forming Plastic Sheet," Mid-Sept '58, p D4, compares the difference methods of thermo-forming plastic sheet materials, their tooling and costs; "How to Design Out Cost of Plastic Parts," Oct 14 '57, p 77, shows how to spot such costly requirements as heavy walls and extra-close tolerances—charts guide selection of basic production processes. "Design Hints for Laminated Parts," Jan '57, p 86, gives best shapes; how reinforced plastic laminates carry loads best. "Designing with Plastics," Mid-Oct '55, p C19, gives basic ground rules for design of molded thermoplastic and thermosetting materials. "For Better Phenolic Molded Parts," Sep 1 '58, p 86, describes process limitations when molding phenolics; how to lower costs.

HOW to MAKE

At this intensity, noise can be more destructive than mechanical vibration. Special speakers and a pentagonal sound chamber simulate noise frequency and intensity met by control components in rocket-powered missiles.

MERWIN T ANDERSON
Test Project Chief
Research and Advanced Development Div
AVCO, Wilmington, Mass.

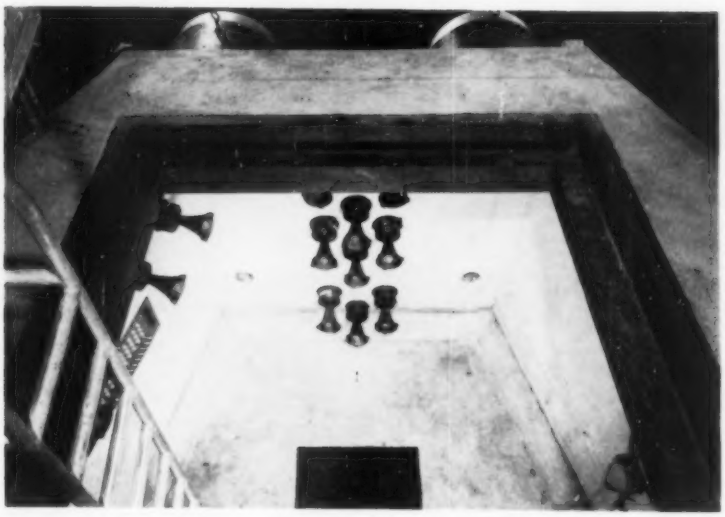
Noise environments encountered by many components and control devices today are often beyond the range of what usual noise generators can produce. Yet in missile applications, for example, it is hardly practical to operate a rocket engine just for the noise. This was the reason for a project at Avco to develop an electromagnetic speaker and a sound chamber for noise levels above 150 db.

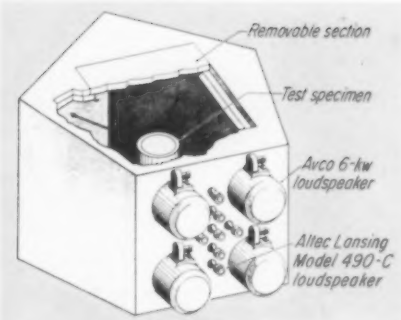
Noise produced by a rocket engine peaks in the range of 100 to 600 cps with sound pressures between 180 and 195 db. Attenuation from distance and housing reduces noise on components to a peak of about 140 db as shown in the curve.

Since the noise is random, an electromagnetic horn-type loudspeaker is a logical transducer, but none were available with the needed power level. A one-ton unit 3 ft in dia and 2 ft long was designed with a 12-in. diaphragm, a converging focusing device and conical horn ending in a 4-in.-dia. opening. When driven by a 6-kw amplifier the speaker produces 155 db random noise in a 10-in.-dia area at 20 to 5000 cps frequency response.

When placed at the end of a molded fiberglass progressive wave tube 10 in. dia and 12 ft long, one of these speakers produces a sound pressure of 155 db with a spectrum closely matching the rocket noise. The tube will take parts up to 5 in. dia without affecting the progressive wave field. But for larger specimens requiring larger-dia tubes, where the power increases with the square of the diameter, a reverberant chamber with reflecting walls offers a better answer.

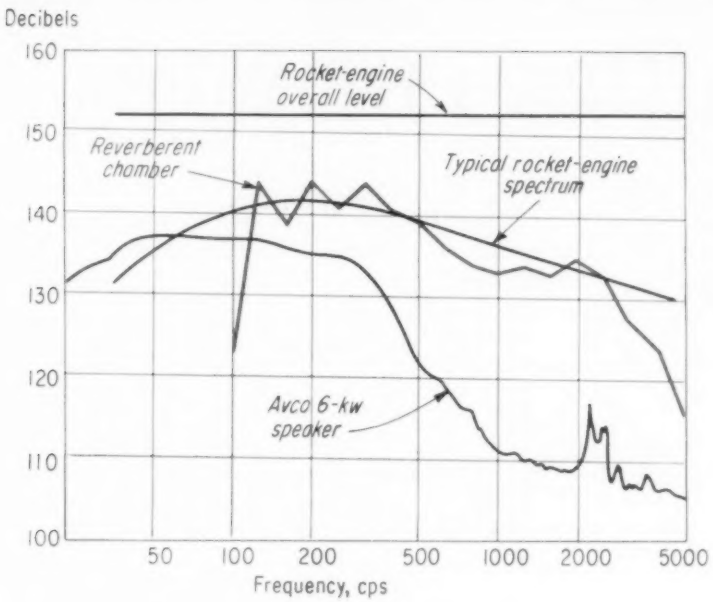
SOUND TESTS at 150 DB





Pentagonal reverberant chamber . . .

7-ft high, with nonparallel floor and roof, can subject 90-cu ft specimens to sound pressures of 152 db with frequency spectrum matching noise from a rocket engine. Reinforced concrete walls are 1 ft thick.



Noise spectrum . . .

for a typical rocket engine is closely matched in the reverberant chamber. Curve for chamber is 1/3 octave-band frequency spectrum; curve for the special 6-kw speaker shows characteristics over its frequency range. Note that lower frequency noise is supplied by special loudspeakers; conventional speakers provide the noise above 800 cps.

In designing such a chamber the major problem was to obtain uniform frequency distribution of standing waves. This led to a chamber with no parallel surfaces—pentagonal with nonparallel floor and ceiling. Walls are approximately 7 ft square, and are 12-in. concrete to attenuate external noise to safe levels.

Conflicting requirements of size, low-frequency cut-off and sound pressure were best met by a 900-cu ft volume (accepting 90-cu ft specimens), fed by four Avco 6-kw speakers mounted on one side of the room. To reinforce the higher frequencies 12 conventional speakers were added. This combination produced a random noise with a sound level of 152 db, closely simulating the environment within a missile powered by a rocket engine.

check these mechanical features

BEFORE SELECTING a FHP MOTOR

For a specified application, consider such characteristics as power and torque of the motor—but don't overlook importance of its mechanical makeup. Here's a guide to basic enclosures, mounting arrangements, bearing types, insulation, and those "extras."

NORMAN L MORGAN
Application Engineer, Special Motor Dept, General Electric Co

It pays to get better acquainted with the mechanical features of fractional-horsepower motors. Knowing their structural makeup—from enclosure to insulation—prepares you to select the motor that will do the job at lowest cost. It gets around the difficulty of depending on published mechanical standards. With motors 5 in. in dia and over, the mechanical features are well defined by the NEMA—but there has been little standardization of smaller sizes. This explains, for example, why one manufacturer's special motor is called a standard model by another—who produces in volume.

But even though mechanical features sometimes vary (for example, a low-power shaded-pole motor does not need an explosionproof enclosure because, in a contaminated area, a self-contained motor and drive unit will do the job easier), you can depend on this—in general, every standard enclosure, mounting and bearing type, and all accessories such as gears and brakes, are available in all the fractional-hp types. This reduces the choice of fractional horsepower motors to basics.

5 BASIC ENCLOSURES

Of the many types listed by NEMA, only a few are applicable to fhp motors.

Open—For cooling purposes, openings permit a passage of external air over and around the windings. The motor is unprotected against contaminates or foreign matter of any type, or from any direction.

Open dripproof—Similar to above but openings are

arranged so liquids or solids falling from any angle of 15° or less from the vertical cannot enter motor interior.

Totally enclosed–Free exchange of air is prevented between inside and outside of the case, but it is not watertight or airtight. Windings are cooled by heat exchange rather than direct entry of cool outside air. Frame size is larger than for an open motor of equal rating because ability to dissipate heat is less; hence cost is proportionately greater.

Totally enclosed fan-cooled–Outer shell is cooled by an internally mounted fan. Heat dissipation is better than above; hence the motor may develop greater horsepower per frame size. Normally built only in the larger fhp sizes, since the saving in size is offset by fan and housing length in smaller frames.

Explosionproof–Can withstand an internal explosion of gas or vapor, and is constructed to prevent ignition by sparks of gas or vapor surrounding the motor. Rugged construction increases cost over other enclosures.

Other basic encloseures–weather protected, dust ignition-proof, lintproof, sanitary motors–are refinements of the types discussed and will be recommended by manufacturers when application warrants.

4 MOUNTING ARRANGEMENTS

Almost all fhp-motor applications can be handled by one of the following mounting methods.

Base–Motor is mounted rigidly to a surface parallel to the shaft. Most common is the foot mount–a contoured plate welded to the stator shell, then bolted to a surface. Variations are a cradle mount (motor clamped at each end) and pad mount (the fastening is screwed into the mounting from the opposite side).

Band mount–Motor, supplied without a mounting arrangement, is held by bands around its circumference.

Resilient mounts–These absorb the motor vibration . . . rubber rings can be attached to each end of the motor and clamped into a cradle, or a rubber pad can be used between motor and base.

End mounts–Several general arrangements are possible. When accurate shaft alignment is not required and end-mounting is called for in the application–for example, a heater-fan motor–the extended motor-through-bolt method is lowest cost. The manufacturer supplies the motor with longer and often stronger clamp bolts, which may be used to attach the motor to its application.

For more accurate alignment of the shaft or a more rigid mounting, face-or flange-mounted motors work best.

"Three-quarter" type motors–units without a shaft-end shield–can be directly mounted to a device. Extended bolts join the motor to the driven device. If this gives rigid mounting and suitable second bearing surface for the motor shaft, it is often the cheapest way.

Where motors are built into another housing–drills, shavers, mixers–only certain parts are needed. Motor is supplied in the form of field and rotor (plus brush mechanism for series motors) with the bearings, while the mounting and housing are part of the application.

2 BEARING TYPES

Together with insulation, bearings are a critical point in motor applications. A motor is only as good as the bearings that support the shaft. But in general, the selection of bearings and lubrication presents little problem since they can be based on application. Main decision is: sleeve or ball bearing? Lubrication is normally only a problem in high- or low-temperature applications or in contaminated areas.

Sleeve bearings–Used where pounding, vibration or thrust are not excessive. A lubrication system is required, or else a large inherent supply of oil with efficient recirculation and a sealed system is necessary.

Sleeve bearings are plain or oilless. The plain types consist of bronze, babbitt, or other metals, and almost always require some sort of recirculating oil system which draws lubricant from a reservoir, pumps it along the bearing surfaces, and returns it to the reservoir. Oilless bearings are made of a porous material, such as sintered bronze, in which the oil is retained and fed to the shaft. In general, their life is limited and, as a rule, they are usually used on inexpensive motors only.

Ball bearings–Are more expensive and have a higher noise level than the sleeve variety, but are needed for speeds above 5000 rpm or for greater than normal axial and radial thrust loads. They are either permanently lubricated and sealed, or supplied with grease fittings.

. . . AND INSULATION

A most critical failure point in a motor is the dielectric breakdown of its insulation system. For all practical purposes the limiting output for a given frame size is determined by the amount of heating that its windings can stand without deterioration of insulation.

Underwriters' Laboratories, NEMA, and other groups have defined several types of insulation systems on the basis of their temperature limits. Most common in the fhp field is Class A insulation, which is limited in total temperature, including ambient, to 105 C at the hottest point of the winding. For higher temperatures–especially in the larger sizes of fhp motors–Class B has a limit of 130 C, and Class H for even higher limits are available in some special lines of motors.

FINALLY, THE EXTRAS

Auxiliary devices can be added to a motor when needed; are standard or special, depending on manufacturer.

Overloads–Protective devices can be manual-reset or automatic. Both types use bimetal disks sensitive to motor temperature and current.

Gears and transmissions–In fhp sizes, integral gearboxes are widely used for low-speed outputs. Many manufacturers build motors incorporated with a gearbox or transmission and sell the unit as package.

Brakes–Fhp motors with integral brakes are not common but, where necessary, several brake arrangements are possible. Most common: disk brakes and hysteresis-clutch type. Electrical method is plugging–electrically reversing the motor field while in operation. Especially useful when positive braking is not required or when slow deceleration can be tolerated. Its advantage: lower cost and smaller size than mechanical methods.

Governors–Speed-control mechanisms are used only on series-type motors, and consist of a centrifugal device that senses motor speed and interrupts the circuit until

speed is reduced to a predetermined value. Accuracy: 2 to 3 % on series motor speed variation.

POINTS TO CHECK

Basic requirements for any application are the approximate speed and torque required for operation. Preset specifications simplify the task—for example, in fan applications the blade manufacturer recommends requirements under set conditions. These cases are rare, however, and approximate speed and torque is given to the motor manufacturer for supplying a sample unit.

Output—Simplest approximation method for horsepower required by a constant torque device is a scale and lever on drive shaft, checking peak loading points and inherent starting loads. If speed is known, average horsepower needed for continuous duty is:

$$\text{Hp} = (\text{torque})\ (\text{rpm})/K$$

where the unit conversion factor, $K = 5250$ if torque is in ft-lb, 84,000 when oz-ft, 63,025 when in.-lb, and 1,008,000 when in.-oz.

If the sample is accompanied by a performance curve, the motor is coupled to te device and operated at nameplate voltage. Operating requirements of the device are determined by comparing the resultant current on universal and dc motors or watt input of the induction motor with its performance curve.

If sample is not precalibrated, it is installed and voltage varied slightly until satisfactory operation is obtained. Using this voltage value, the approximate horsepower requirement of the application is calculated by the method outlined below for the motor type.

Normal squirrel-cage induction motors are used as torque-calibration units to determine the loading characteristics of the device. Motor line voltage is adjusted for satisfactory application operation and inputs are read. These input readings are duplicated on a brake to determine hp loads. A correct motor winding can then be designed by the motor manufacturer.

Another is the watt-loss method. If the sample motor has good speed stability, the approximate power requirement for the application is the difference between the no-load watts and full-load watts while running the device. Method is less accurate and not widely used.

Series-type motors require only that the line current be read as the voltage is changed until proper operation of the driven device is obtained. Reason: series-motor torque is almost proportional to line current within normal motor operating range and is nearly independent of heating. However, speed varies considerably with voltage, hence a speed measurement allows plotting application torque requirements over a considerable range of motor electrical values.

Shunt and compound-wound motors can have torque read at any particular speed by maintaining constant field voltage and reading armature current. With a constant load, speed varies linearly with changes in armature voltage; conversely, with fixed speed, torque is nearly proportional to armature current.

Duty cycle—Must be considered to determine correct motor output. Many devices require several outputs during an operating cycle. These are difficult to calculate exactly. But, for initial estimating, the root-mean-squared horsepower of a typical cycle will give a closer approximation of required power than any of the continuous-duty formulas.

$$\text{Hp}_{rms} = \sqrt{\frac{(\text{hp})^2\ (\text{sec}_1) + (\text{hp})^2\ (\text{sec}_2) + \ldots (\text{hp})^2\ (\text{sec}_n)}{(\text{sec}_1) + (\text{sec}_2) + \ldots (\text{sec}_n) + \tfrac{1}{2}\ \text{idle time}^*}}$$

* ½ idle time for enclosed motors

When applicable, this formula will give the increased rating possible from intermittent duty operating between max and min power-out requirements. Formula is only a guide and does not replace sample motor testing in fractional-horsepower sizes.

Also, a check on operation should be made at min anticipated line voltage (80 to 90% of rated) under field conditions.

Heat runs—Another important application point to check is the motor-winding temperature. Motor temperature is especially important in applications being submitted to the Underwriters' Laboratories and Canadian Standards Association for inspection.

In the fhp field two methods are used—thermocouple (thermometer) method and the resistance method.

Former involves placing thermocouples in the windings, on the case, and in a position to measure ambient air temperature. Thermocouples have a linear temperature-voltage relationship and are read on a sensitive millivoltmeter. Method is easy but not accurate since there is no assurance that the hottest point of the winding is being measured.

Resistance method considers the motor-winding resistance to be proportional to the temperature of the copper. Temperature rise is determined on the increase of winding resistance at ultimate operation temperature over resistance measured cold. Temperature-rise reading must consider the ambient temperature of the motor. Therefore,

$$C_{rise} = (R_{hot}/R_{cold})\ (234.5 + T_{cold}) - (234.5 + T_a)$$

Where T_{cold} equals winding temperature in C prior to operation, T_a is ambient temperature in C at completion of test and is not necessarily equal to T_{cold} because of possible temperature variations during test. It is important to read the hot temperature as few seconds as possible after the motor is turned off.

The first few minutes of cooling follow closely a linear semi-Log function; consequently zero-time ultimate resistance can be extrapolated on a time from shutdown vs resistance line drawn on semi-Log paper. In general, ordinary applications with Class A insulations are allowed a 65-C temperature rise in a 40-C ambient. However, heating limits are well defined by NEMA and Underwriters' Laboratories for various types of insulation, and their standard publications should be referred to for determining allowable temperature rises in specific fractional-horsepower applications.

EDITOR'S NOTE: A follow-up article by the same author will discuss the influence of rotor type and starting method on choice of fractional-horsepower motors.

For more about mechanical and electrical features mentioned in the present article, see "Here's Help in Selecting the Right Motor," Oct 13 '57, p 86—a bibliography of relevant material appearing in these pages over the past few years. These motor and control articles span the range from 1/2000 to 4000 hp.

. . . Hottest cost-saving idea in the controls field!

DON'T BE UNDERBID on equipment or systems involving metal bellows and accessories. Specify the completely assembled "package" from Bridgeport . . and save on handling, assembling, inspections, testing and paper work. Quantity purchasing and superior facilities assure you *absolute minimum* cost. Pass this saving on when you submit your bid.

Bellows metals to meet your tough conditions of temperature, pressure, vibration and corrosion . . . in sizes from $\frac{1}{4}$" O.D. to several inches O.D. Get the complete story on custom-engineered Bridgeport Packaged Bellows. Write for Bulletin A 1012!

Mr. Controls

Robertshaw-Fulton
CONTROLS COMPANY

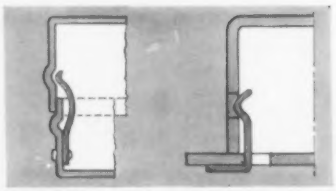
BRIDGEPORT THERMOSTAT DIVISION
Milford, Connecticut

CIRCLE 128 READER SERVICE CARD

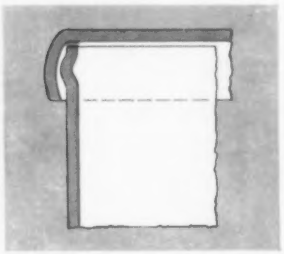
20 SIMPLE LOCKING

Springs, latches, eccentric cams, and other arrangements that hold two parts together

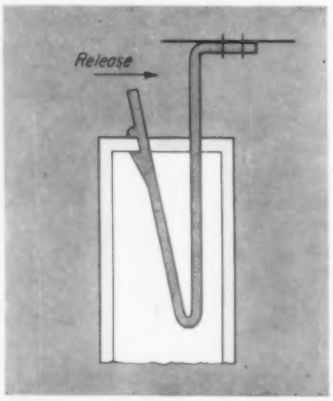
SPRINGS



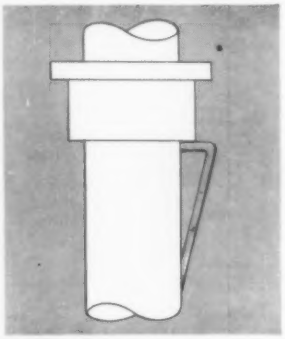
1 **Spring catch** acts as pawl-type catch for sliding members



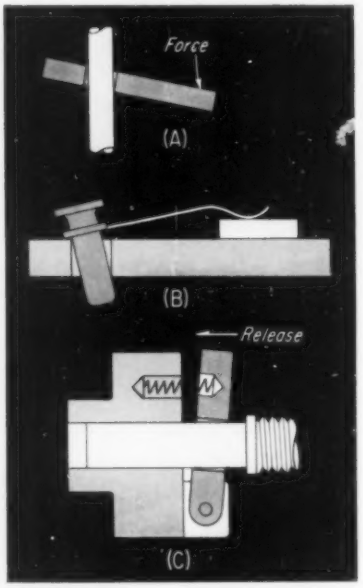
2 **Snap-on lid** embodies pawl principle in parts themselves



3 **Spring hook** locates itself, then locks to hold part

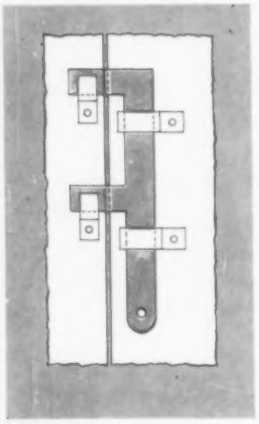


4 **Umbrella-type catch** is analagous to spring hook

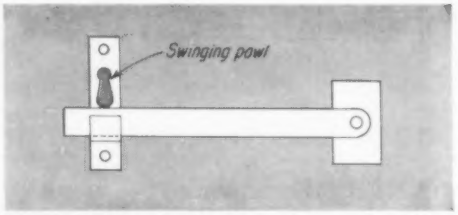


5 **Tilt-lock principle** (A) has many applications—examples are: holding specimen on microscope table (B); lock for vacuum-cleaner tube (C)

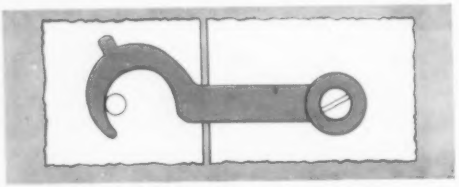
LATCHES



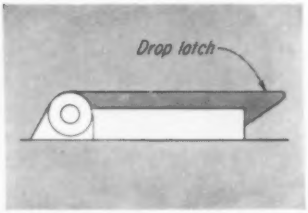
6 **Double latch** for high and narrow doors



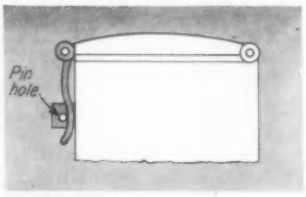
7 **Pawl** holds this latch



8 **Hook-latch** is inexpensive way to lock small lids



9 **Drop-latch** holds bar in position

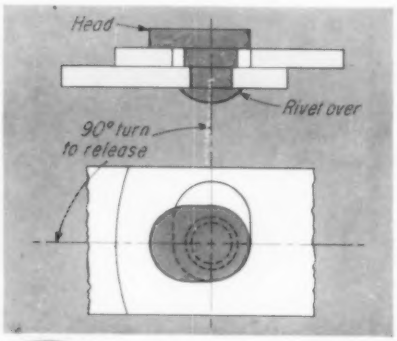


10 **Hasp and staple** (with or without pin)

DEVICES

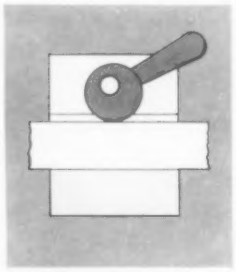
FEDERICO STRASSER, *Mankowitz & Strasser Ltd, Santiago, Chile*

ECCENTRICS



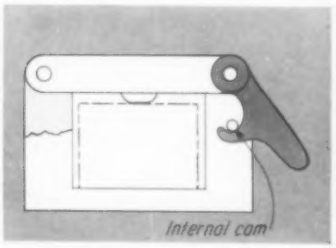
11

Off-center head holds parts together in position shown, releases when one part is given a turn of 90 degrees



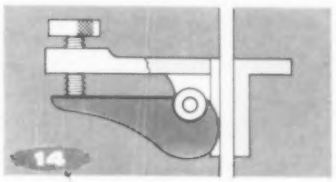
12

External cam exerts nigh friction-forces that provide clamping action



13

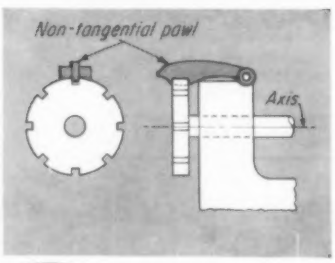
Internal cam here serves as lock for hinged cover



14

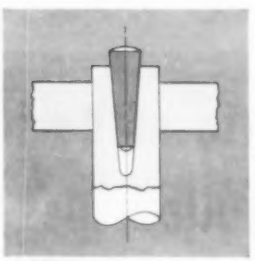
Screw-actuated cam exerts considerable clamping force

MISCELLANEOUS



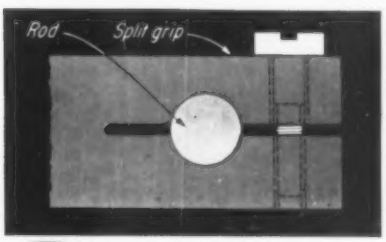
15

Pawl parallel to axis locks rotary device



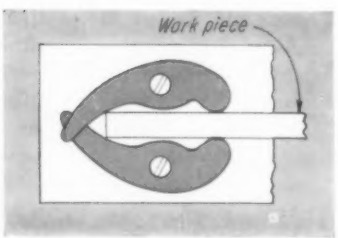
16

Taper pin expands rod, creates large holding forces



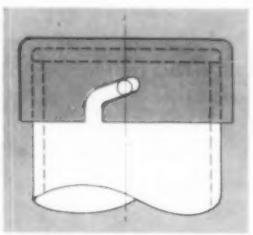
17

Split grip tightened by screw provides powerful rod-clamp



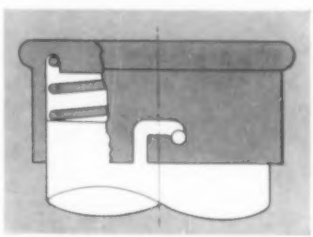
18

Carpenter clamps are self-locking, held tight by the workpiece itself



19

Bayonet-lock wedge action can't be shaken loose



20

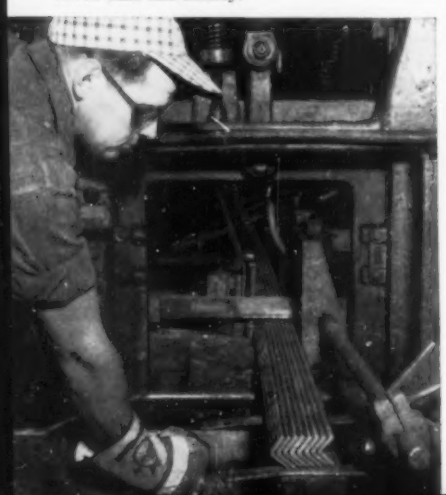
Spring-loaded bayonet lock provides positive grip

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS

This is a picture of teamwork. C. G. Merker, U. S. Steel Metallurgist, discusses this cost-saving production change with Dick Sprucebank, Grating Shop Foreman, and Mr. P. H. Rollings, Division Purchasing Agent.

Stair tread nose plate made in one operation from steel already rolled to shape

One operation – sawing – completed this nose plate made from a special angle section rolled with a raised tread on the top side. Sawing 8 to 10 bars at a time speeds up operations, saves time and money.



Blaw Knox Company, Pittsburgh, makes thousands of open grate stair treads yearly. The nose plate was previously fabricated in such a way that excessive scrap losses and high costs were often incurred.

To solve this problem, U. S. Steel suggested a special angle section with a raised tread rolled on the top side. This eliminated shearing and forming operations, and the resulting scrap loss. The nose pieces could be sawed 8 or 10 bars at a time from 20-foot lengths of steel. The result was substantial savings in cost.

USS Special Sections can be made in many forms so that mass-produced parts can be cut to length as required and processed to finished parts by simplified fabrication. Frequently, this method will substantially reduce costs and result in improved parts. Why not write for complete information? United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS is a registered trademark

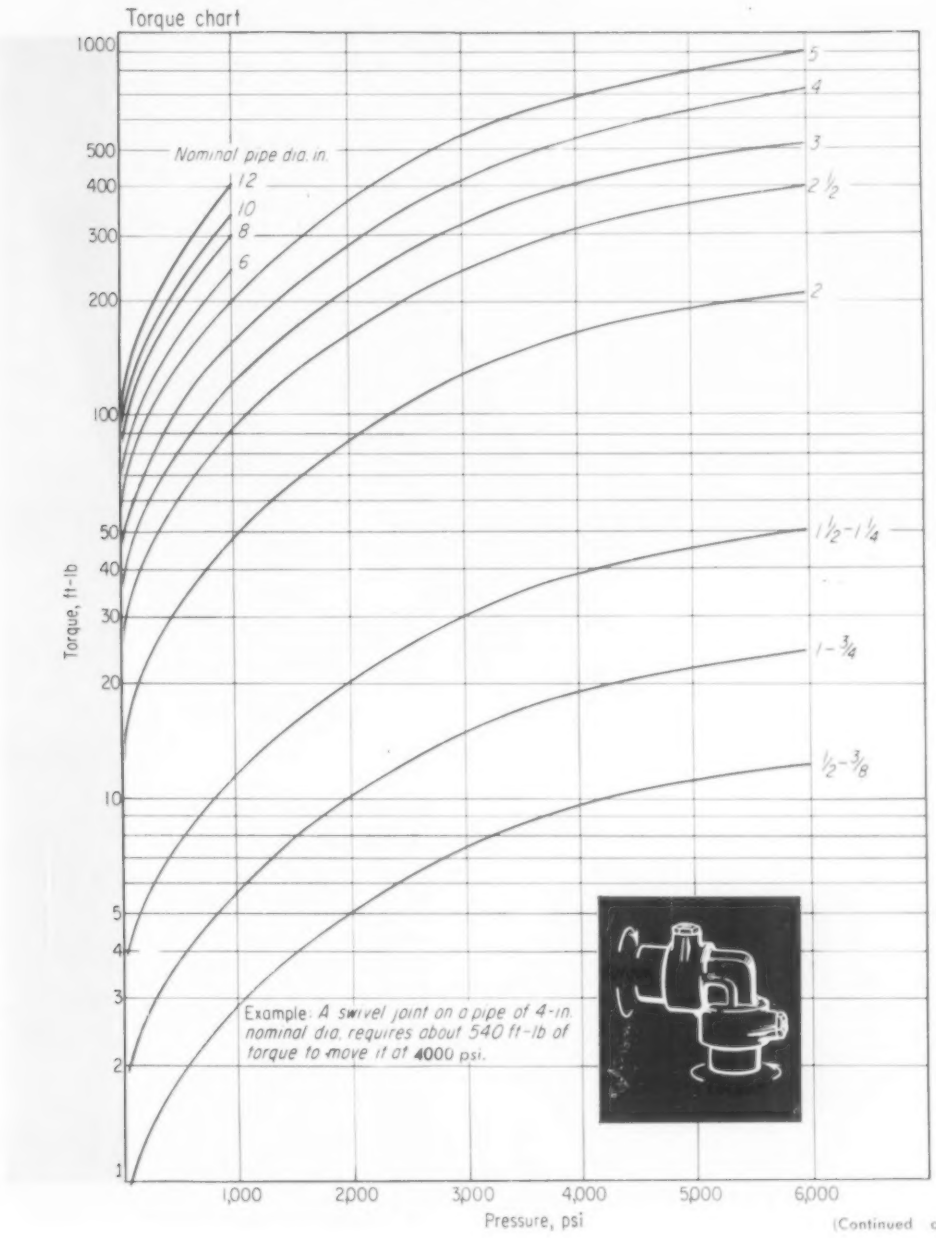
United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company

USS United States Steel

Third in a series of articles by the author on pipefittings that serve as flexible connections . . .

Charts find torque, pressure loss of SWIVEL JOINTS

G M BAGNARD, Chief Engineer, Chiksan Co, Brea, Calif.



(Continued on page 69)

US PowerGrip

THE ORIGINAL BELT WITH TEETH

The U.S. PowerGrip "Timing"® Belt is one belt that delivers POSITIVE drive, non-slip performance all the time. During the eight years since it was patented by "U.S." this "Timing" belt with teeth has been popularly referred to as the "T" belt.

So indispensable has this "Timing" belt become that thousands of plants, girding for power and automation, are using the T belt. It not only gives non-slip performance, it will never stretch and will outlast all others. Besides, it requires no lubrication, no maintenance. And since this belt requires virtually no initial tension at installation, think of how this prolongs bearing life.

Your U. S. Power Transmission Distributor carries a full line of stock sizes, has the experience and engineering know-how to help you convert quickly and easily.

• • •

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United States Rubber

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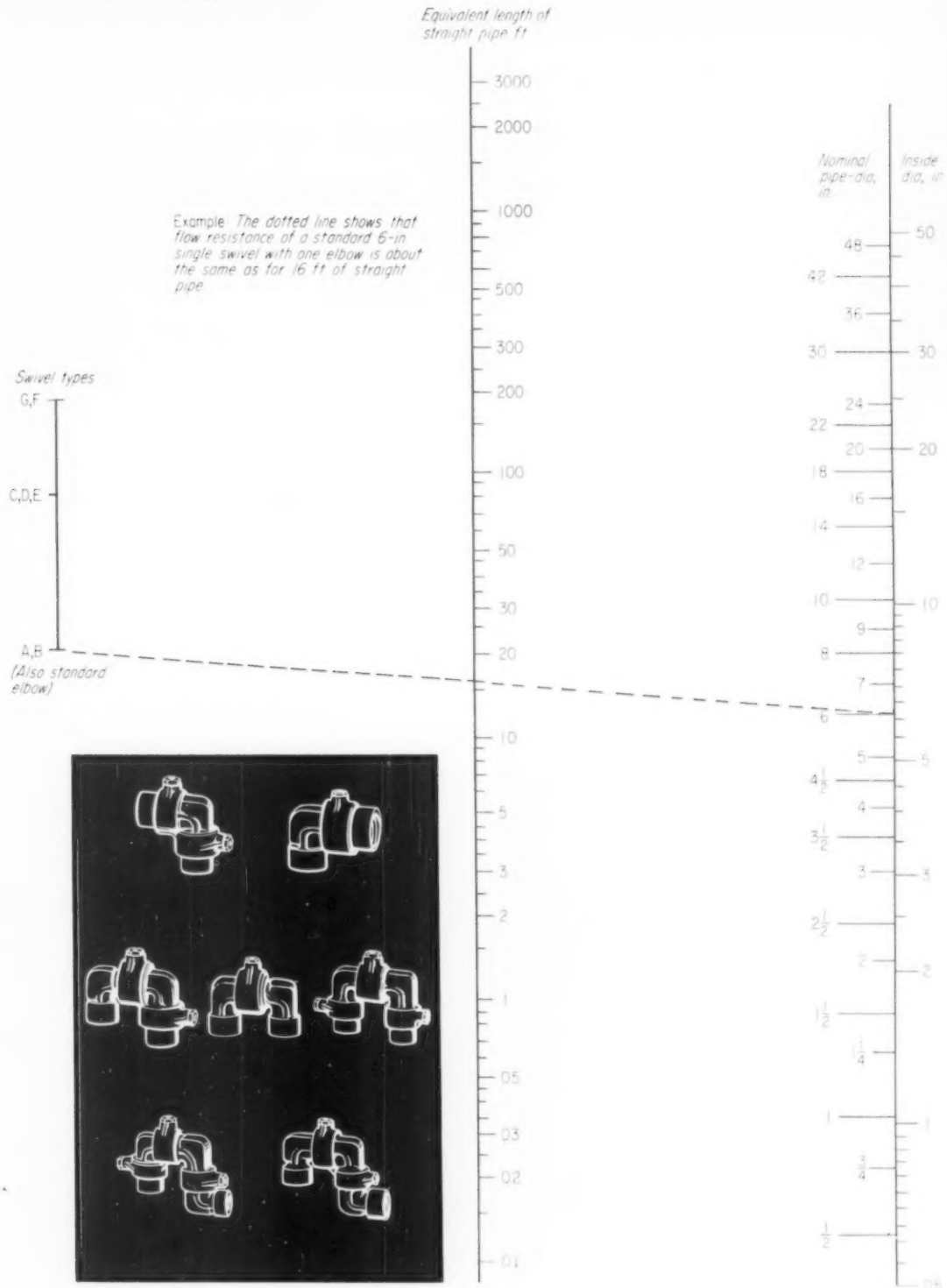
Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

SWIVEL JOINTS (cont.)

Pressure-loss nomograph



NEWS FROM FLEXONICS

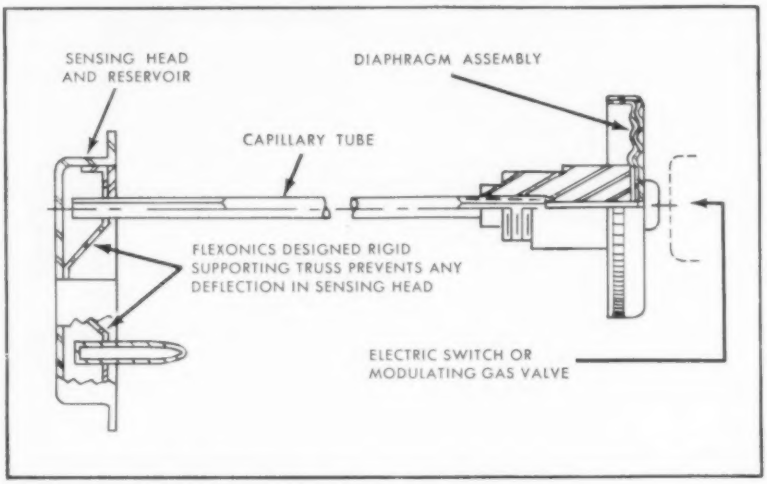
BELLOWS APPLICATION ENGINEERING

One of a series of reports on more effective use of metallic bellows in new or unusual applications.

Flexon Temperature Sensor Provides Improved Top Burner Control for Ranges

Intimate understanding of the product manufacturer's requirements by the vendor almost always results in better products at lower cost. An outstanding example of what development of this kind of understanding can produce is a new temperature sensing device developed by the Bellows Division of Flexonics Corporation for use by a leading manufacturer of free-standing and built-in ranges.

The manufacturer, in his continuous search for ways to improve his products, was attracted to a Flexonics temperature sensor for surface unit control on ranges. Through close cooperation of the engineering departments of the two companies, the Flexon unit was thoroughly tested and modified to meet or exceed all of the manufacturer's rigid performance specifications at a unit price that is a fraction of previous sensor cost.


SENSING HEAD AND RESERVOIR
DIAPHRAGM ASSEMBLY
CAPILLARY TUBE
FLEXONICS DESIGNED RIGID SUPPORTING TRUSS PREVENTS ANY DEFLECTION IN SENSING HEAD
ELECTRIC SWITCH OR MODULATING GAS VALVE

The complete Flexon surface unit control sensor unit.

Operation of the Sensor

Installed, the sensing head of the Flexon unit is mounted in the center of a surface unit where it contacts the bottom of a cooking utensil placed on the surface unit. Its job is to sense the temperature of the utensil and transmit the information to a control that adjusts current flow to maintain the desired, pre-set utensil temperature.

Sketch of surface unit showing the position of the sensing head.

The sensing head serves as a reservoir for the fluid charge of the unit. Expansion or contraction of the fluid with utensil temperature changes is transmitted by means of a capillary tube to a diaphragm assembly. The resulting motion of the diaphragm turns the surface unit off and on to maintain utensil temperature within very close limits.

Advantages of the Flexon Sensor

From an operating standpoint, the Flexonics sensor provides improved sensitivity which results from a combination of design features. The sensing head is very flat (within .005" T.I.R.) which permits better contact with the utensil. Contact is further improved because the design of the head makes it easier to install and maintain in a level position. In addition, the combination of metals used in the unit provides more efficient heat transfer than conventional sensing heads.

Design and manufacture of the diaphragm establishes response and life characteristics far superior to conventional sensors. This in turn further contributes to the unit's accurate control.

In the highly competitive appliance industry, the substantial cost reduction made possible by the Flexon unit is particularly important.

How to Take Advantage of Flexonics Assistance

Whenever you have a design requirement involving response to temperature—or pressure—changes, put the problem in the hands of the Flexonics Bellows Application Engineering Staff at the earliest possible stage. Their experience is your best assurance of getting the performance you require at the lowest possible cost.

For your reference file, write for your copy of the Flexon Bellows Design Guide, 20 pages of helpful design data. There's no obligation.

BELLOWS DIVISION
B-50

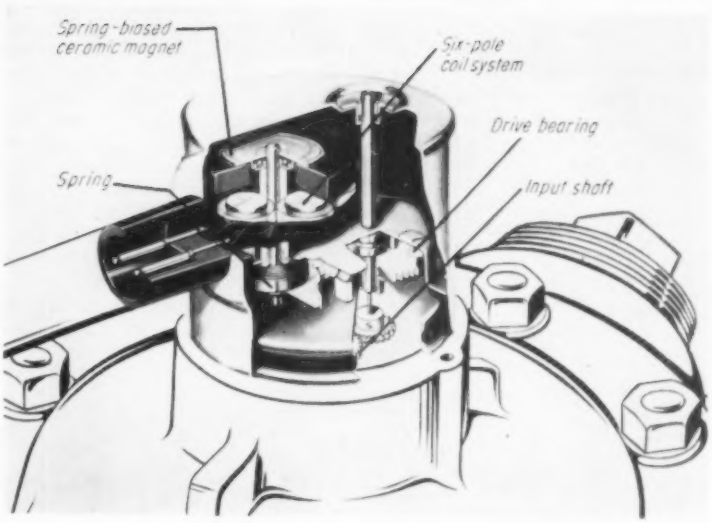
Flexonics *Corporation*

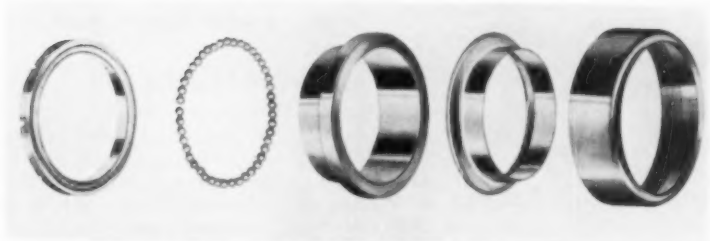
1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS
In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario
Also Manufacturers of Rubber and Metal Hose Assemblies • Expansion Joints • Aircraft Components

Remote registering counter .

provides centralized indication for metering liquids and counting machine cycles. Requires no outside power for operation. For each 90° of shaft rotation, generator converts a small amount of torque, to 0.625 in.-lb max, into a 3 to 5-v electrical pulse. Pulse is carried over to sealed, weatherproof register, which may be located ½ mile or more from unit. Readings may be taken at some distances from machine, eliminating difficult or hazardous observations. Suitable, too, for applications where external power sources are undesirable. Operating speed is 40 rpm (160 pulses) max. Approximate cost, less than $30 per unit. From stock. **Badger Meter Mfg Co, 4545 W Brown Deer Rd, Milwaukee.**

Circle 1, Reader Service Card

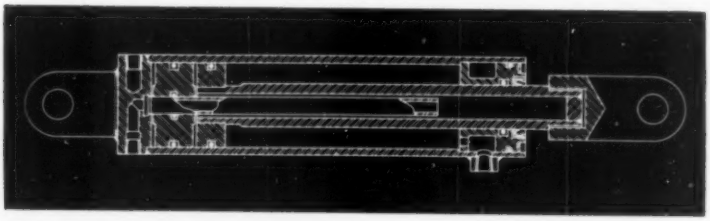




Lightweight rotation joints . . .

are said to be corrosion-resistant and to have leakage rates less than required by specifications. Used between sections of pneumatic systems that are hinged or rotate about each other, for transfer of ram or bleed air, joints accommodate pressures to 390 psi and temperatures of −55 to 735 F. Capable of full 360° rotation. Stainless steel ball-bearing design provides low breakaway torque. In 2¼-in. size, for example, torque is about 60 in.-lb. Designed for airborne use. Marman Div, Aeroquip Corp, **11214 Exposition Blvd, Los Angeles 64.**

Circle 2, Reader Service Card



Hydraulic cylinder stroke . . .

is controlled hydraulically from a remote station or location. Valve, which can be used with any 4-way hydraulic system, controls floating piston within cylinder. Piston is hydraulically positioned and set at any desired stroke length, repeating this stroke until piston position is changed. Made to ASAE specifications or to 8-in. bores and to 8-ft strokes to suit specific applications. Unit with 4-in. bore, 8-in. stroke, including valve, lists for $115. Normal delivery on standard 4-in. bore units with strokes to about 42 in. is approximately 10 days. **Densmore Engineering Co Inc, 235 E. Greenleaf St, Compton, Calf.**

Circle 3, Reader Service Card

Miniature pneumatic switch . . .

in models for gage and differential pressures, has operating range of 0 to 30 psi, temperature range of −55 to 160 F and port size of ⅛-27 ANPT. Switches are 1½ in. dia, about 2 in. long and weigh about 1.2 oz. Integral snap-action, SPDT electrical switch is potted. Preset switches are said to withstand 15 g. Solder terminals are provided. **Meletron Corp, 950 E Highland Ave, Los Angeles 38.**

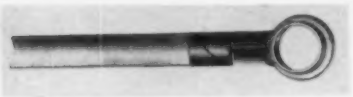
Circle 4, Reader Service Card

High-temperature paint . . .

is said to withstand 1700 F and virtually fuse with hot surfaces to form continuous, uniform coating. Made of high-heat-resistant aluminum, combining leafing and nonleafing characteristics, and colored metallic pigments in a silicone base. Paint is said to air-dry in 30 min. Also protects surfaces from 200 F upwards. Aluminum, metallic blue, metallic red and gold are standard available colors. Packaged in quart, 1-gal. and 5-gal. containers, priced at $3.95, $14.85 and $72.50, respectively. FOB Cleveland. From stock. **Speco Inc, 7308 Associate Ave, Cleveland 9.**

Circle 5, Reader Service Card

. . . CONTINUED ON PAGE 72



Extruded ring terminals . . .

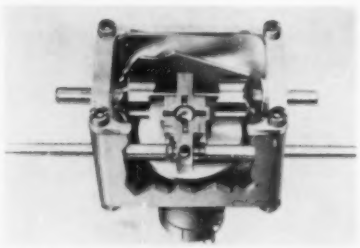
also act as spacers or lock washers. ER-70 and 80 terminals are stamped from 0.020 high brass and high brass tinned. Made with 0.179 stud hole and supplied with one wire or wire and insulation. Insulation ears accommodate thick wall insulation and provide strong, in-line attachments. Produced in strip form on disposable reels. **Electric Terminal Corp, Warwick Industrial Park, Providence 5.**

Circle 6, Reader Service Card

Straight centrifugal clutch . . .

with only four moving parts is said to be particularly applicable to motors and small gas engines. Can be used to accelerate high-inertia loads where smooth starting is essential; gives overload protection in situations where damaging overloads may occur; suitable for pulsating loads. In addition, it provides freewheeling when prime mover is stopped and can be used to furnish dual drive from motor or engine. Also useful for standby power applications. Available in capacities of 1 to 15 ft-lb at from 1400 to 3600 rpm. Offered in choice of 3, 3½ and 4½ in. OD with ⅞ to 1 in. bore. **Fairbanks, Morse & Co, Magneto Div, Beloit, Wis.**

Circle 7, Reader Service Card



Linear integrator . . .

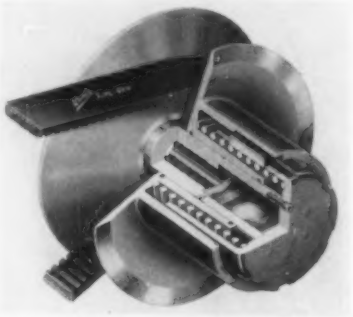
has micro ball-bearing carriage design that is said to extend life and improve accuracy up to 100% over earlier models. Area of contact between ball bearings and steel integrating balls is 0.5% of contact surface of sleeve carriage used in previous models, eliminating friction loss. Requires less than 0.3 in.-oz force to move input shaft. Design permits precision factory-adjustment. Device is said to permit 0.01% reproducibility. Integrator, in aluminum alloy case, is 1⅞ x 2¾ x 3¾ in. and weighs 17 oz. May be used as mechanical device to convert linear position to rotary velocity or as precise variable speed drive. **Librascope, 808 Western Ave, Glendale, Calif.**

Circle 8, Reader Service Card

Magnesium sheet alloy . . .

does not require stress relief after welding. Contains zinc and rare earth metal as alloying constituents and is said to have best toughness of any magnesium sheet alloy on market. Typical properties in H24 temper (strain hardened, then partially annealed) include tensile strength to 38,000 psi, tensile yield of 28,000 psi, compressive yield of 26,000 psi. Alloy is also furnished fully annealed. Max advantages are obtained when used for welding to magnesium extrusions that also do not require post-welding stress relief. In full commercial production. **Madison Div, Dow Chemical Co, Madison, Ill.**

Circle 9, Reader Service Card



Nonsticking pulley design . . .

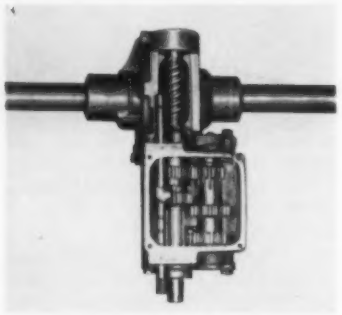
also prevents fretting corrosion and freezing. Bearing surfaces are re-oiled from oil reservoir with each rotation of pulley. Continuous rotational pumping action of flange hub on sleeve constantly renews and distributes oil film evenly on bearing surfaces. Series of nylon-faced rubber keys, located outside bearing surfaces, transmit power from stationary to moving flange through movable sleeve cap. Torsionally resilient keys carry belt torque, evenly distribute load and equally transmit power by both flanges. O-ring oil seals are said to retain lubricant for long periods between refills. Five pulleys are rated 2, 3, 5, 10 and 15 hp, based at constant torque and for max speeds. **T B Wood's Sons Co, Chambersburg, Penna.**

Circle 10, Reader Service Card

Torque motor for 600 F . . .

operation does not require complicated cooling systems or thermal lag provisions in high-temperature applications. Has midposition force of over 8 lb; stroke of 0.008 in. at radius of 0.750 in.; measures 1⅝ x 1 1/16 x 1¾ in. and weighs 10 oz. Requires 4-w-input electrical power. **American Measurement & Control Inc, 240 Calvary St, Waltham 54, Mass.**

Circle 11, Reader Service Card



Automatic transmission . . .

and differential assembly is for 1- to 9-hp heavy-duty applications. All running parts operate on ball or needle bearing axles and hanger brackets. Axle shafts revolve on oil seal and oil-less bearing on ends of axle. Standard unit has 34-in. axles. Differential can be supplied separately if desired. Assembly was specifically designed for small equipment. **Hawkins Metal Products Co, Dept D-227, 324 Thompson St, PO Box 12, Lebanon, Ind.**

Circle 12, Reader Service Card

Immersion heating unit . . .

has cast insert that may be removed from outer flanged shell assembly without draining tank. Electric heating unit is for heat transfer in oils, water, caustics and alkali cleaning solutions and vapor degreasing compounds. Available for pipe and finned-tube heaters. Made in 7, 10 and 15 kw, 220, 440 and 550 v; single and 3-phase; for 3-in. pipe and up, Schedule 40, with lengths from 2 to 6 ft. **Thermel Inc, 9400 Robinsion Rd, Frankiin Park, Ill.**

Circle 13, Reader Service Card

Variable sheave and clutch . . .

in a single unit provides cushioned starting for V-belt drives. Clutch is dry fluid type with heat-treated steel shot used as driving medium. Sheave diameter adjustable from 5½ to 10 in. by turning sheaves on hub. Flanges turn together; right and left-hand threads keep groove on same center. Sheave is size 9D, taking a section R belt. Bores range from 1½ to 1⅞ in. Max rating for 1750-rpm motor, with sheave at mid pitch driving an 8-in. fixed sheave, is approx. 10 hp. **Dodge Mfg Co, Mishawaka, Ind.**

Circle 14, Reader Service Card

High-temperature valve . . .

utilizes heat-resistant diaphragm material that may be used in continuous service to 250 F. Hydraulically activated, remote

. . . CONTINUED ON PAGE 74

BRIDGEPORT BRASS
COPPER ALLOY BULLETIN

Reporting New Developments in Copper-Brass Alloys and Metalworking Methods

USE BRIDGEPORT'S WAREHOUSE STORES FOR FAST SERVICE

As close as your phone . . . Bridgeport's supply network puts brass, copper and aluminum mill products within easy reach. With 7 plants and 11 warehouses, strategically located throughout the country, Bridgeport can give you fast, efficient service on any need, large or small. As a result, your inventory and ordering problems are simplified, your production schedules more easily met. Try Bridgeport's "Johnny-on-the-spot" service next time you need brass, copper and aluminum. It will save you time, trouble and money. For prompt deliveries, call the warehouse nearest you:

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MAin 3-0273
AComa 2-4108

Los Angeles 22, Calif.
6500 E. Flotilla Street
RAymond 3-5101
PArkview 1-5171

Minneapolis 15, Minn.
124 12th Ave., South
FEderal 9-7061

Newark (Hillside), N. J.
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130 Potrero Avenue
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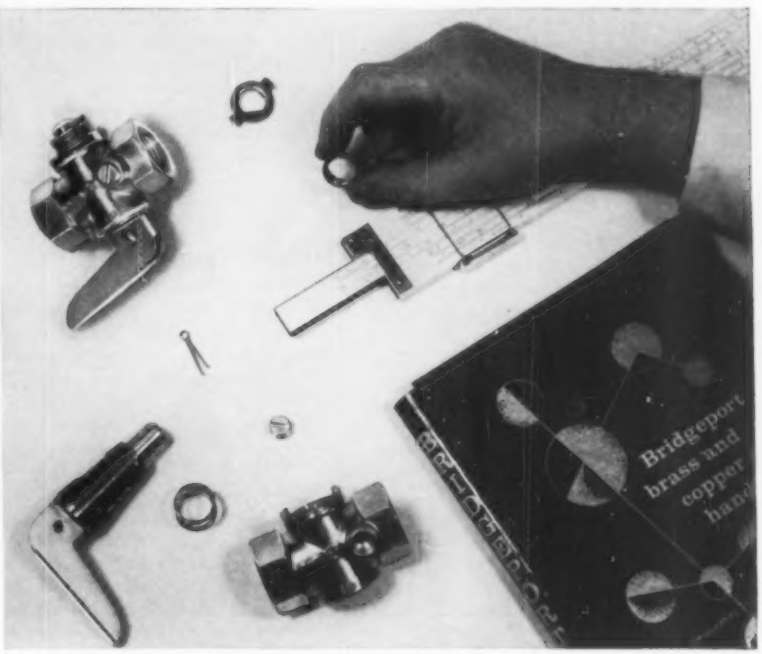
Bridgeport also maintains Sales Offices in principal cities. Check your local directory for address and phone number.



Every Product Should Take Advantage of Today's Favorable Cost of Solid Brass

Of all the qualities that recommend brass for finished products and parts, price is now one of its most attractive.

Price—a vitally important element in any product—puts brass within immediate reach of all manufacturers who find that quality, cost and availability are essential to the success of *their* products or parts.

Consider these advantages offered to you now by Bridgeport as a prime supplier of copper and brass:

1. A newly installed Sendzimir Mill and continuous strip annealer that deliver high-quality brass strip under close gage and grain size control.
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Behind this is Bridgeport's Technical Service ready to help you in problems of selection, application and fabrication. Take advantage of it. Your Bridgeport Salesman is the man to see. Call him today.

BRIDGEPORT BRASS

Bridgeport Brass Company, Bridgeport 2, Connecticut • Sales Offices in Principal Cities
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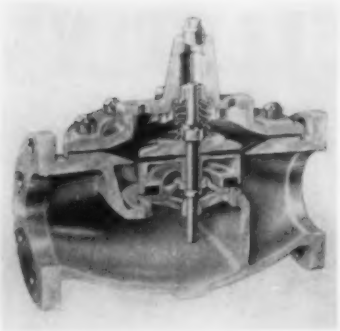
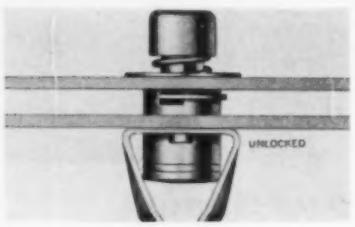


control valve has backless design. Valve disk that opens and closes valve is integral part of diaghragm assembly. No lubrication or packing is said to be required. Closed by hydraulic pressure applied to valve cover through a small control tube. Pressure is derived from process stream itself, with main line tapped at some point upstream of valve inlet. Valve opens when pressure is released. Offered in ¼ to 16-in. sizes, with screwed or flanged connections. **Automatic Valve Systems Co, 1535 Monrovia Ave, Newport Beach, Calif.**

Circle 15, on Reader Service Card



Press-to-lock fastener . . .

can be used for securing inspection ports, modular units, panels and sections requiring quick installation and removal. Fasteners require only thumb pressure for installation or removal. Sample, do-it-yourself kit is offered. **Deutsch Fastener Corp, PO Box 61072, Los Angeles 61.**

Circle 16, on Reader Service Card

Sliding-seal control valve . . .

with threaded exhaust ports is offered in a series of 2, 3 and 4-way types with levers for hand or mechanical actuation. Valve has ¼ NPT ports. Flow capacity is 55 cfm to accommodate larger cylinders. Two and three-way valves are designed so that any port can be inlet port. Adjacent ports are outlet or cylinder ports and the remaining port on 4-way valve becomes exhaust port. Precision-lapped stainless steel disk slides on bronze rings. Ring, O-ring and spring are interchangeable. **A Schrader's Son, 470 Vanderbilt Ave, Brooklyn, NY.**

Circle 17, on Reader Service Card

Quick set silicone rubber . . .

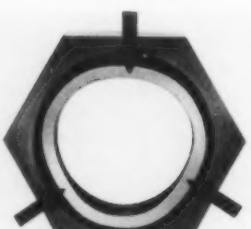
vulcanizes at room temperature in 30 min., about 20 times faster than conventional room-temperature vulcanizing silicone rubbers. Retains flexibility from −70 to 500 F, has good electrical insulating properties and resists weathering, moisture, ozone and corona, like regular heat-cured silicone rubber. Suitable for sealing and caulking metal-to-metal and metal-to-rubber joints, potting and encapsulating electrical and electronic parts; as a mold or impression material for making prototype parts; as a shock- and vibration-absorber for delicate components. **Dow Corning Corp, Midland, Mich.**

Circle 18, on Reader Service Card

Miniature proximity pickup . . .

for use while submerged or on machines using coating oils or coolants is offered in two models. Both have 10-ft cable potted in place for water and oil resistance. One has cable terminated with 3-pin connector for use with control units with 3-pin receptacles; other has cable with terminal lugs for connection to control units with barrier-type terminal strips. Sensing face is 5/16 in. dia; over-all length, $1\frac{31}{32}$ in. Mounting thread is ⅜-24. Detects ferrous and non-ferrous metal parts with less than $\frac{1}{10}$ in. dia and can be excited by gear teeth of 10 diametral pitch. Can detect both stationary and moving metal pieces. Operating clearances for metal pieces over ⅜ in. dia are up to ¼ in. Operates in temperatures to 200 F max. **Electro Products Laboratories, 4500 N Ravenswood Ave, Chicago 40.**

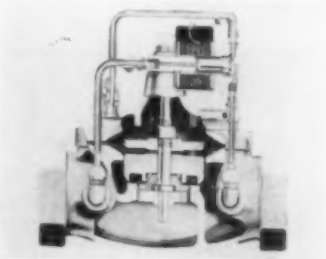
Circle 19, on Reader Service Card



Reusable torque locknut . . .

is one-piece fastener with preformed threads in locking section. Three sectors of tapered portion are preformed inwardly and elastically returned to a circular configuration, creating inward and downward pressure, when nut is applied to a bolt. Pressure produces contact between load-carrying flanks of nut and bolt threads. Closed stress path in locking portion of nut and distribution of locking pressure are said to produce locking device with high fatigue life. Prelubricated to permit high-speed power wrenching without galling. **National Machine Products Co, Utica, Mich.**

Circle 20, on Reader Service Card



Solenoid control valve . . .

is pilot-operated, diaphragm-actuated globe or angle valve. Operates automatically from pressure of line or independent supply, pneumatic or hydraulic. May be installed vertically or horizontally. Pressure rating is 160 psi ac or 100 psi dc. Offered in 1 to 3-in. screwed and to 4-in. flanged unit. Resilient disks in main valve and solenoid provide drip-tight closing. Valve is packless, requiring no lubrication. Available energized to open and de-energized to open. May be equipped for control of opening or closing speed or both. Power consumption is 10.5 w ac, 10 w dc. Available in 115, 230, 460 v, 50 cps; 24, 48, 115, 230 or 460 v, 60 cps, and 6, 12, 24, 115 and 230 v dc. **Cla-val Co, 17th and Placentia, Newport Beach, Calif.**

Circle 21, on Reader Service Card

Expanded titanium sheet . . .

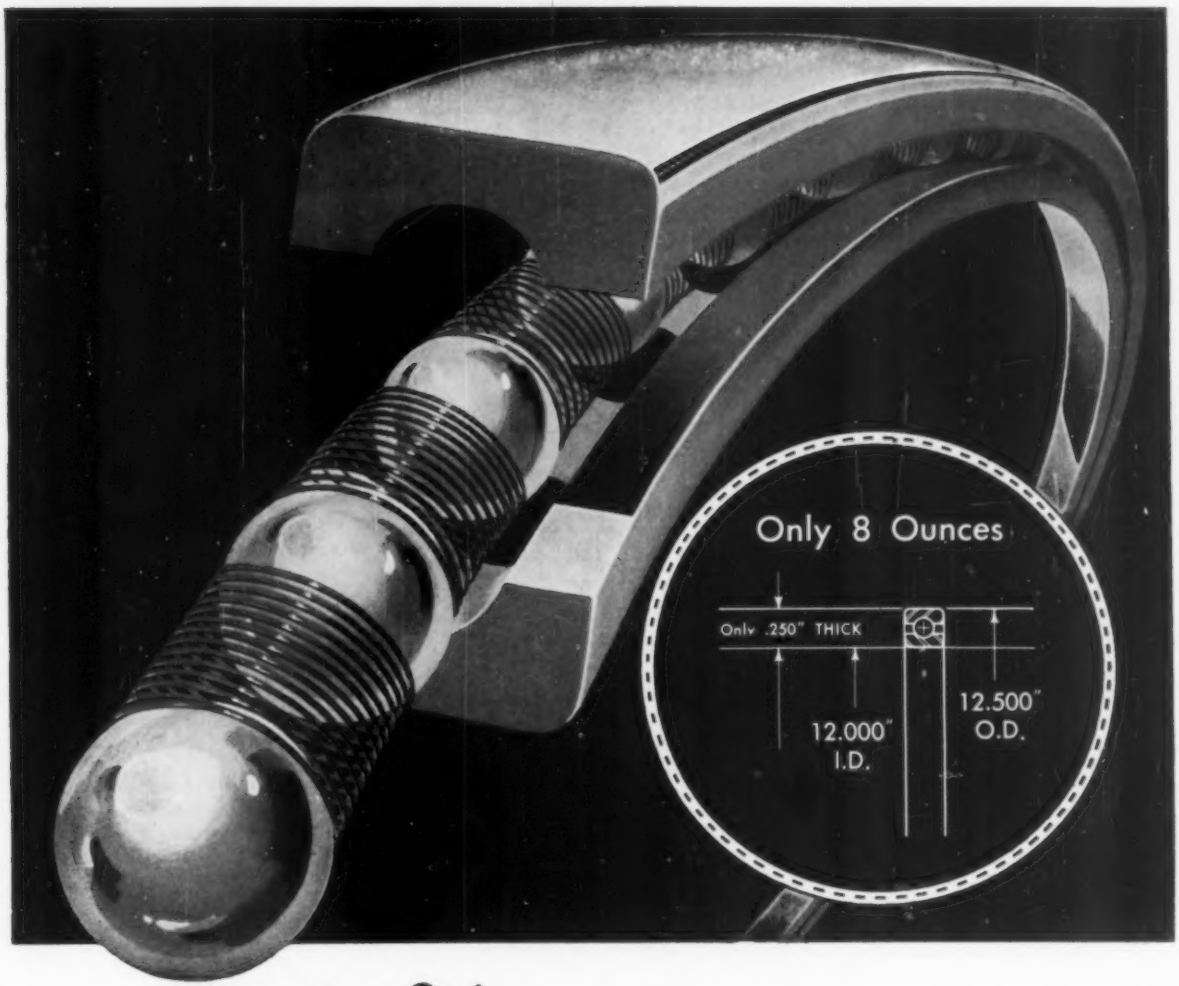
for use in plating, chemical and other applications requiring corrosion resistance is available in gages from 0.050 to 0.125 in. into ½ to 1½-in. diamonds, in standard 48 x 96-in. sheets. Material is reported to permit bend radius four times metal thickness in longitudinal or transverse direction after sandblasting and pickling. Annealing does not improve bend factor. Expanded sheet is offered in unflattened or flattened mesh. Now available in production quantities. **Mallory-Sharon Metals Corp, Niles, Ohio.**

Circle 22, on Reader Service Card

Rigid PVC moldings . . .

free of thermal decomposition, are available in more complex shapes, thinner sections, better weld strengths, improved gloss and more uniform surface appearance. Molding material is electronically preheated to 440 F and then plunger-molded with

. . . CONTINUED ON PAGE 76



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 51RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 5/16" and in bore diameters from 5" to 40".

K-554

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" bore to 178" outside diameter...
Taper Roller • Roller Thrust • Roller Radial • Ball Radial • Ball Thrust Bearings

pressure to 15,000 psi. Time-temperature relationship is basis of new process. Method is said to be particularly important when considering the higher molecular weight resins. Process permits use of resins and stabilizers too heat-sensitive for conventional long-cycle techniques and requires no special equipment. **Union Carbide Plastics Co, 655 Madison Ave, NYC.**

Circle 23, Reader Service Card

Fhp variable-speed drives . . .

all-electric, have 8:1 speed range. Drives from ¼ through ¾ hp are for small conveyors, presses, machines, agitators and similar applications. Single half-wave thyratron electronic tube rectifies standard in-plant single-phase, 50 or 60-cps, 220-v ac power to variable-speed drive motor. Control panel is built around a printed circuit board. Control unit weighs 30 lb, measures about 9½ x 14 x 8¼ in. Can be mounted on driven machine or at remote location. Said to withstand normal vibrations encountered in direct machine attachment. **Reliance Electric & Engineering Co, 24701 Euclid Ave, Cleveland 17.**

Circle 24, Reader Service Card

Moment-of-inertia rule . . .

converts irregular section into two simple rectangles and determines moment of inertia of each by formula. Totals are then added to obtain moment of inertia of original irregular section. Accuracy is said to be within 1 or 2%. Accompanied by 4-pp instruction booklet. Cardboard rule is 50¢. **Lincoln Electric Co, Cleveland 17.**

Circle 25, Reader Service Card

Piano-type switches . . .

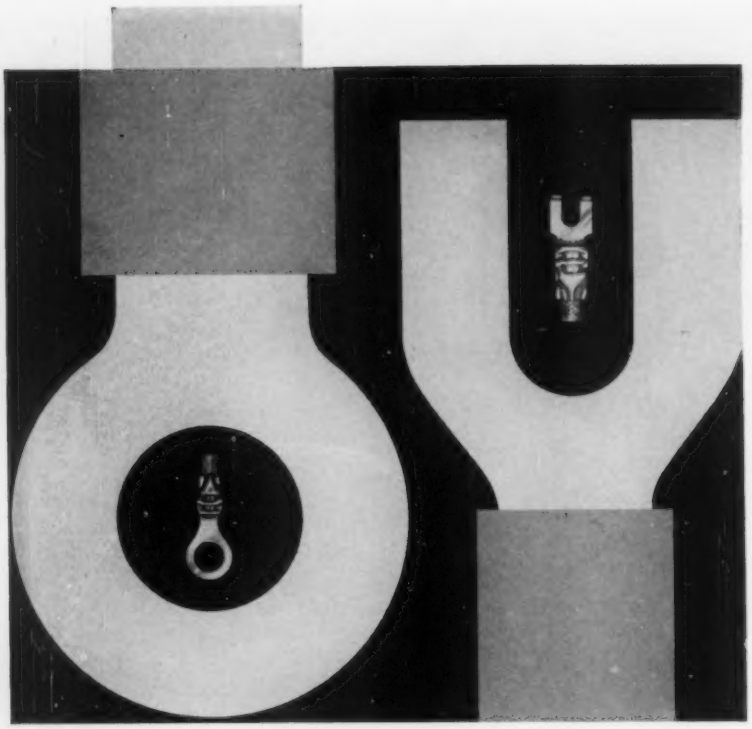
are available with any ganging arrangement desired, up to 15 stations per switch, 2, 4, 5 or 6 sets of SPDT contacts per station. Contacts, which can be removed for cleaning without severing soldered connections, have max rating of 500 ma, 500 v ac or dc, 50-w load. Contact pressure is 100 gm. Short or long levers are optional with exchangeable button, illuminated if desired. Made in West Germany. **Available from International Electro Exchange, 2307 Foshay Tower, Minneapolis 2.**

Circle 26, Reader Service Card

Motion analysis . . .

device has neon light source, giving adjustable flashing rate; 5:1 ratio vernier control adjusts rate in two ranges, covering from 8 to 30 and 32 to 100 pps, respectively. Calibrated for reading, and fiducials are included for all popular movie camera speeds. Output is provided for con-

(Continued on page 80)



For perfect insulated termination . . .

faster . . . specify the A-MP®

PRE-INSULATED DIAMOND GRIP terminal

If you need terminals with bonded insulation—if you need corrosion resistance and wire-supporting vibration resistance—you have it instantly in one closure of A-MP's matched crimping tool. Only one lightning-quick step for crimp-sure optimum strength and conductivity. A-MP PRE-INSULATED DIAMOND GRIP Terminals exceed the most rigid military and commercial specifications.

A-MP's precision-engineered terminals are matched to precision-engineered tools that make an exact crimp every time, never too little, never too much. Perfect terminations—whether you need one or a million. No great operating skill necessary. A-MP's match-mated tooling does all the work and at lower installed cost than other methods of wire termination. Wire range is from No. 26 to No. 10.

To solve your wire-end problems, we maintain an international engineering service.

For the full story on the A-MP PRE-INSULATED DIAMOND GRIP line, send for our catalog.

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new Maxitorq

electric clutches and brakes

9000 SERIES

a design feature of pratt & whitney numerical control, ultra-precision hole grinders

Again a famous machine tool builder favors today's outstanding electric clutches and brakes

Previously, Pratt & Whitney incorporated MAXITORQ Clutches in their high-precision jig borers. Proved performance led their engineers to test and accept the new 9000 series MAXITORQ Electric Clutches for their latest development . . . the fully automatic, numerically controlled, ultra-precision Vertical Hole Grinder and Electrolimit Jig Borers. Inset photograph above shows the compact and "clean" installation of two of these clutches in the carriage control drive gear box.

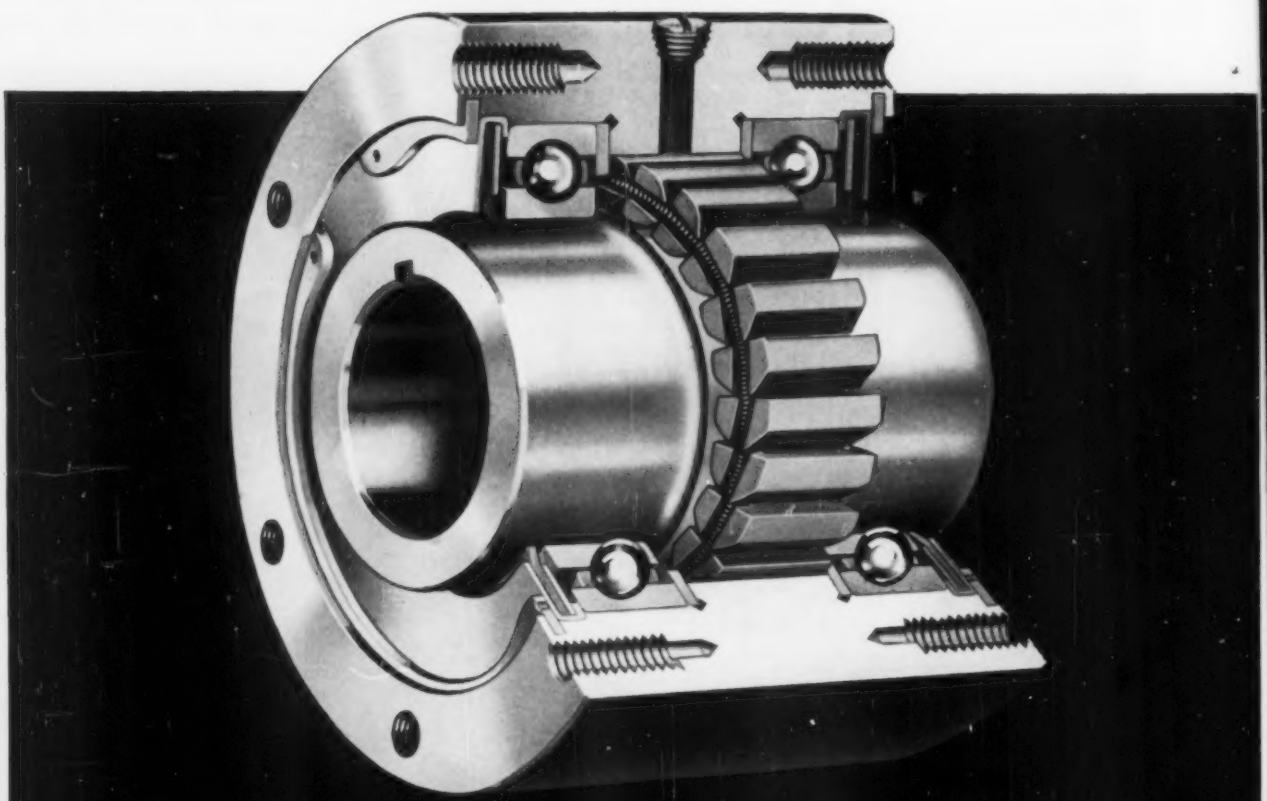
Incorporating new and advanced design principles, the 9000 Series MAXITORQ Electric Clutch is well adapted to machine tool drives. It is simple in design . . . built to machine tool standards . . . requires no adjustments. It can be used *either as a clutch or brake*. Disc separators not only separate discs but also break up residual magnetism, and result in extremely fast, positive action with no drag or heating in neutral. Design principles have been PROVED through years of service. There are few moving parts. Electrical operating unit remains stationary—hence, there are no troublesome slip rings or brushes; no difficult wiring problems. Clutches operate on standard 110 V a.c. converted to 90 V d.c. Other voltages on special order.

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us.

Phone, wire or write Dept. PE-12 for new #9000 Series bulletin

The Carlyle Johnson Machine Company, Manchester, Conn.

The OVER-RUNNING CLUTCH With

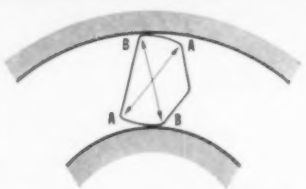


OVER-RUNNING · INDEXING
BACKSTOPPING

STANDARD CLUTCHES FOR ORIGINAL EQUIPMENT NEEDS

Formsprag Clutches are used throughout industry, from business machines to aircraft, in bore sizes from ¼" to 12". Several informative bulletins available, including: "Design Considerations for High-Speed Over-running Clutches," "Ten Design Ideas", "Seven Ways to Reduce Space and Costs", plus the complete Formsprag catalog. Write for any one or all.

HERE'S



The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

Greatest Torque
Per Inch – Per Ounce

Modern power transmission design demands the utmost torque capacity in an absolute minimum of space. That's why designers in every field specify Formsprag clutches . . . the *modern* way to transmit power on over-running, back-stopping and indexing applications.

Along with highest possible torque capacity for its size and weight, every Formsprag clutch offers such additional benefits as internal simplicity (just four basic parts), no measurable backlash, light weight, compactness, extreme precision and long, trouble-free life. Formsprag's exclusive, patented principle is unlimited in application, yet this full-complement sprag type clutch is extremely simple in design and operation.

There is a size and model Formsprag clutch for every application. Standard models include sleeve bearing, ball bearing, miniature, and large bore backstop types. These are shown in the current Formsprag catalog, complete with specifications, performance data and design suggestions. Ask your Formsprag distributor, or write direct for your copy. For special applications, Formsprag engineers will recommend a modified standard or design a special. Send details of your requirements.

FORMSPRAG COMPANY
23607 Hoover Road, Dept. 100
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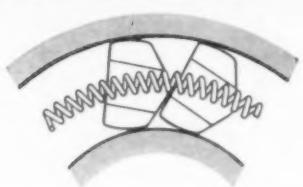
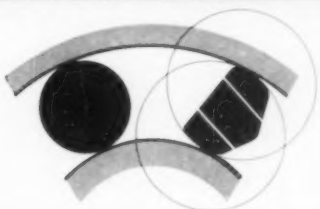
FORMSPRAG CLUTCHES

World's Largest Exclusive Manufacturer of Over-running Clutches

HOW IT WORKS

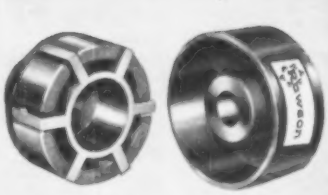




An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

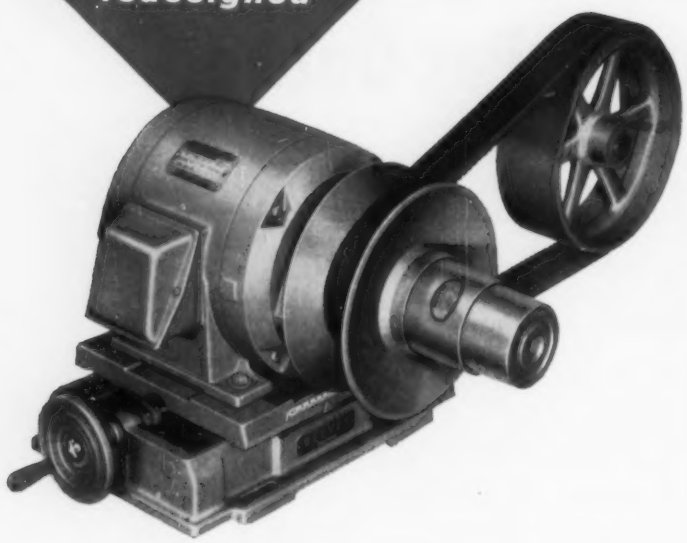
Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

FOR NO-LOAD STARTS



Specify Rawson Automatic Centrifugal Clutches and Clutch Couplings. They protect the prime mover, eliminate need for costly reduced voltage starting equipment, permit use of less expensive smaller motors to start high inertia loads. Completely automatic and entirely mechanical in operation. Rawson clutches provide full overload protection, never need adjustment. Write for the new Rawson Clutch Catalog now.

completely redesigned



REEVES® *Vari-Speed MOTOR PULLEY*

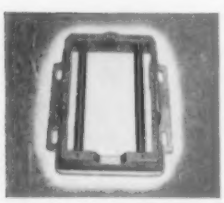
Here is variable speed control in its most simplified form . . . variable speed control with new economy.

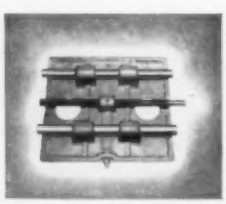
Disc assemblies have just three main parts: two smooth-face, cone-shaped discs; and the belt tension spring. There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit both old and new NEMA motors.

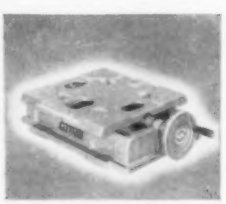
Separately mounted countershaft assemblies are available. For complete information on sizes and available controls, write for Bulletin K36b-V582.

Split section view of sliding disc shows how REEVES "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. One lubrication point services entire disc assembly.

New precision bases Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy bases are specially manufactured to assure positive, easy adjustment and accurate speed control.





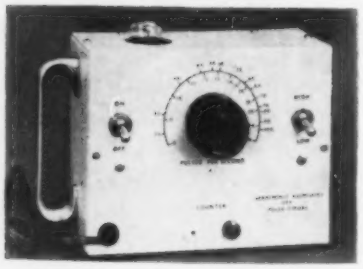


Base and motor slide rods manufactured for precision fit and true alignment. Fully-lubricated shifting screw and precision features provide easy shifting.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana



nection of digital counter. Can also trigger slave white-light for photographic purposes. Hand-held unit is 6½ x 4⅞ x 2¾ in. $99.50, FOB Concord. **Aerotronic Associates, Concord, NH.**

Circle 27, Reader Service Card

Fusion-sealed capacitor . . .

gives continued peak performance under moist or corrosive conditions. Unit employs air-tight glass-metal seal where lead joins capacitor body and fusion seal around perimeter. Said to show no significant change in capacitance or increase in dielectric loss after more than 200 hr in boiling saline solution. Size-10 units, currently available in limited quantities, have capacitance range of 240 mmfd and dc working voltage of up to 500 at 257 F. Operates in temperatures of −67 to 257 F with no derating necessary. Guaranteed for 2000 hr at 257 F with 150% of rated voltage applied. **Corning Glass Works, Electronic Products Div, Bradford, Penna.**

Circle 28, Reader Service Card

Adjustable-voltage drive . . .

of anode transformer type has speed range to 100:1 and speed regulation ½% of base speed with line voltage fluctuation of 10%. Control circuit has two control tubes, one for amplification, the other for voltage regulation. Other circuit elements are static or semiconductor components. Standard packages are rated ¾ to 40 hp. Features include dynamic braking, dual-voltage operation and adjustable current (torque) limit control. **Square D Co, 4041 N Richards St, Milwaukee 12.**

Circle 29, Reader Service Card

Larger-size photoheads . . .

for electronic counters operate at a distance up to 30 in. between light source and photocell. Heads can be assembled so jarring will not knock them out of focus. Larger size can be used for counting large, irregular-shaped objects on conveyors. Counters are transistor-equipped. Count rate is 30,000 per min. for counters with one glow transfer counting tube. Units can be enclosed and are for continuous-operation in industrial applications. **Veeder-Root Inc, Hartford, Conn.**

Circle 30, Reader Service Card

Versatile ACIPCO SPUN TUBES

Stainless steel, carbon steel, alloy iron or special analyses—versatile ACIPCO tubes are "custom-spun" to the exact physical, chemical and metallurgical specifications required by design, manufacturing and end-use conditions.

Because they are centrifugally spun, the metal grain structure of ACIPCO tubes is dense, non-directional and porosity-free. This *superior* grain structure not only makes ACIPCO tubes easier to machine to close tolerances, but also results in greater strength and durability. In addition, the inherent dimensional stability and concentricity of ACIPCO tubes make dynamic balance easier to attain in finished products.

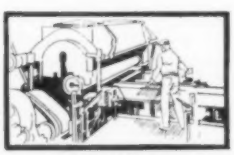
ACIPCO'S complete, integrated facilities for casting, heat-treating, machining, fabricating and testing offer the additional advantages of "one source—from start to finish" service.

Call or write today for information about ACIPCO tube applications in your field, or for expert technical assistance on your specific tubular metal problem.

SIZE RANGE: Lengths up to 410" have been produced to meet modern machinery requirements. OD's from 2.25" to 50"; wall thicknesses from .25" to 4".

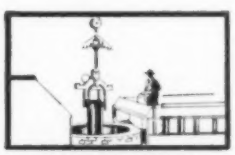
ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

FINISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.



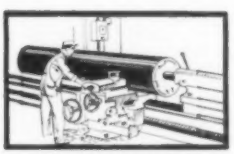
SPINNING

ACIPCO tubes are centrifugally spun to exact physical and metallurgical specifications. Thus, the exact size and metal analysis your process or project requires is assured.



HEAT TREATING

Modern equipment for uniform, controlled heat treating and quenching is an ACIPCO advantage for users of steel tubes where specific physical, mechanical and other metal properties are required.



MACHINING

ACIPCO'S machine shop, one of the South's most completely equipped, performs a full range of machine shop operations including turning, boring, drilling, facing, grinding, metallizing, polishing and honing.

FABRICATION

Complete, integrated facilities for machining, welding, finishing and heat treating of tubular parts save time and expense for ACIPCO customers.

TECHNICAL ASSISTANCE

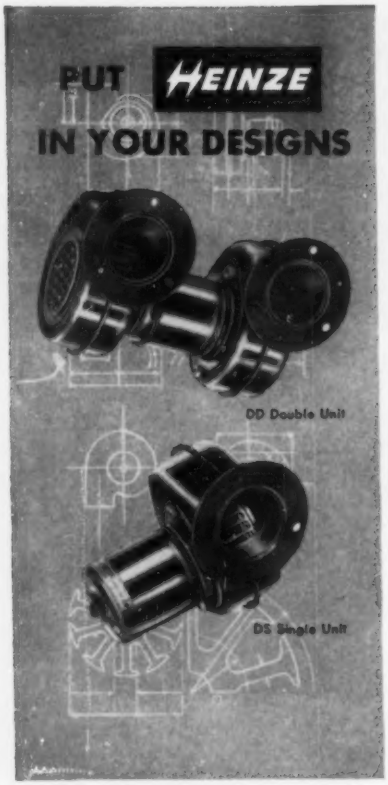
A staff of highly trained engineers, metallurgists, chemists, and craftsmen is available to designers and manufacturers who specify ACIPCO spun tubes.

Special Products Division

AMERICAN CAST IRON PIPE CO.

ACIPCO

PHONE AL 1-8121, EXT. 285 • BIRMINGHAM, ALA.



TYPE D BLOWERS

long life
simple maintenance

Single or double blowers, with durable metal housing, are powered by type D shaded pole induction motor. Rugged units require little oiling, won't interfere with radio or TV. Standard operation is on 115 V, 60 cycles, AC. Single unit has load speed of 3200 rpm, 55 cfm; double unit operates at 3100 rpm, 100 cfm. Other frequencies and voltages available.

Heinze Blowers are designed to your exact specifications — for vending machines, photo dark rooms, laboratories, kitchens, refrigerators, air conditioning units, furnace draft boosters, animated displays, cooling electronic equipment, and other general cooling applications. Write for new catalog to Department F

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.

SUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 84.

WHEELS, RIMS AND RIM ACCESSORIES—Catalog, 94 pp. Information, engineering data and picture on rims, wheels, tools and rim accessories. Includes step-by-step procedure for mounting and demounting rims and operating instructions for using hydraulic tools. With dimensional data and drawings. Indexed for use. Goodyear Tire & Rubber Co, Metal Products Div, Akron 16.

Circle 31, Reader Service Card

COPPER ALLOY LEXICON—Publication B-11D, 24 pp. Terms and definitions applying to brass mill products in any form as supplied by mills are included in alphabetical order. American Brass Co, Dept SBR, Waterbury 20, Conn.

Circle 32, Reader Service Card

TRANSISTOR FUNDAMENTALS — Booklet 4T37, 48 pp. Basic information on transistor theory and circuit applications. Includes circuit diagrams and explanatory drawings; 48 multiple-choice review questions based on text. Answers to questions comprise last portion of book. Radio Corp of America, 30 Rockefeller Plaza, New York 20.

Circle 33, Reader Service Card

HYDRAULIC WEIGHING SYSTEMS—Bulletin 582, 16 pp. Plan-it-yourself-type catalog facilitates application of systems to weighing jobs. Brochure is sectionalized to provide access to engineering and application data. Pricelist is integral part of catalog. Questionnaire and sketch sheet check accuracy of selection and pricing. Application examples show selection methods. A H Emery Co, New Canaan, Conn.

Circle 34, Reader Service Card

ALUMINUM IN ELECTRICAL SYSTEMS—Brochure, 32 pp. Based on comprehensive study, including data from a survey of 400 electrical contractors. Reports on current economies of choosing aluminum for various electrical applications and products, including conduit, and wire and cable. Aluminum Co of America, 754 Alcoa Bldg, Pittsburgh 19.

Circle 35, Reader Service Card

CENTRIFUGAL PUMPS—Bulletin 720.4, 8 pp. Describes line of single-stage, side-suction centrifugal pumps available in 13 sizes, 1¼ to 8 in. Specifications, dimensional chart, materials on construction and parts—interchangeability charts and performance curves. Goulds Pumps Inc, 50 Black Brook Rd, Seneca Falls, NY.

Circle 36, Reader Service Card

LAMINATED PLASTICS — Catalog 20.000.13, 12 pp. Lists and describes laminates which conform to NRMA and military specs as well as special grades for specific applications. Also includes property tables, fabrication information and characteristics. Richardson Co, 2731 Lake St, Melrose Park, Ill.

Circle 37, Reader Service Card

ELECTROMECHANICAL PARTS — Booklet, 8 pp. Discusses design, engineering and production of electromechanical assemblies and precision gears. Atlas Precision Products Co, Div Prudential Industries Inc, Castor & Kensington Aves, Philadelphia 24.

Circle 38, Reader Service Card

CONTINUOUS HINGES—Catalog 258, 16 pp. Specifications and dimensions of continuous hinges available in steel, brass, stainless steel or aluminum. With photos, dimensional drawings and profiles of miscellaneous custom hinges. National Lock Co, Rockford, Ill.

Circle 39, Reader Service Card

FLUID-POWER EQUIPMENT—Bulletin 10051-G, 12 pp. Includes specifications, illustrations and descriptive matter on line of standard pumps, motors, transmissions, cylinders, servo components, valves and accessories. Oilgear Co, 1570V W Pierce St, Milwaukee 4.

Circle 40, Reader Service Card

ANALOG-TO-DIGITAL CONVERTER—Brochure D1.03, 4 pp. Provides design information and shows typical pulse output waveforms. Describes applications and specifications of each piece of equipment. Data Instruments Div, Telecomputing Corp, 12838 Saticoy St, North Hollywood, Calif.

Circle 41, Reader Service Card

FLUID-CONTROL SYSTEMS—Bulletin, 4 pp. Describes and illustrates valves, accessories and control systems for in-flight and ground handling of oils, fuels, oxidizers and liquid or gaseous coolants, hydraulic fluids. Basic valve design feat-

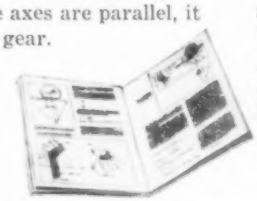
(Continued on page 84)

★ Useful though uncommon

★ Easy to cut

Tapered gears, although not commonly used, offer a number of advantages when you have a design problem requiring an angular relationship between gear shafts. Production is no problem because, with the proper fixtures, tapered gears can be cut rapidly and economically on a Fellows Gear Shaper.

The tapered gear is simply one whose axis is at an angle to that of the conventional spur or helical gear with which it meshes. If the two axes are at right angles, the "tapered" gear becomes a face gear. If the axes are parallel, it is an ordinary cylindrical gear.



As a result of the use of tapered gears in an aircraft engine, an article giving basic formulae and design considerations was written by a Fellows engineer and published in 1948. Increased interest in this type of gear has since resulted in a number of other applications in machine tools, marine drives, speed reducers and missile projectors.

Because of this increased interest, reprints of the article, "Designing Tapered Gears," are being made available. If you would like a copy, simply write to our main plant in Springfield, Vermont.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE *Fellows* *Gear Production Equipment*

FAST, POSITIVE, LEAKPROOF from 1 to 3000 psi

NEW DECCTO CHECK VALVE

Fast acting with leakproof closing under tough operating conditions, the new DECCTO check valve is dependable yet costs less.

- Working pressure 1 to 3000 psi.
- Operating temperature range -65° F. to 275° F.
- Cracking pressure from 1 psi up.
- Excellent design removes chatter or hammering.
- Efficient flow characteristics with minimum flow restrictions.
- Easily installed in any mounting position.
- Premium quality at minimum cost.
- "Off-the-shelf" delivery.

COMPARE PRICE AND DELIVERY

For original equipment or replacement parts, specify Bruning hydraulic components.

Bruning has a complete line of high performance hydraulic and pneumatic couplers, cylinders and check valves.

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THE BRUNING COMPANY

611 So. 9th St., Lincoln, Nebraska

Catalogs and Bulletins.....continued

ures are included. Koehler Aircraft Products Co, 409 Leo St, Dayton 4, Ohio.

Circle 42, Reader Service Card

CASTINGS AND MANUFACTURING FACILITIES—Brochure, 8 pp. Describes and illustrates quality control, metallurgical control, castings facilities, manufacturing facilities and personnel. Includes chart of casting specs for various grades of irons. Dalton Foundries Inc, Warsaw, Ind.

Circle 43, Reader Service Card

ELECTRIC STRIP HEATER—Bulletin F-1613, 4 pp. Illustrates 32 applications. Includes uses of straight and curved elements in a wide range of equipment sizes and shapes. Charts outline range of sizes, wattages, sheaths and special features available for about 500 standard models of 11 basic types. Edwin L Wiegand Co, 7500 Thomas Blvd, Pittsburgh 8.

Circle 44, Reader Service Card

HIGH-TEMPERATURE ALLOY—Data card TDC-189, 2 pp. Tells of high-temperature properties, chemical composition, size ranges, and short-time tensile and rupture properties of alloy developed initially for resistance to corrosion. Tubular Products Div, Babcock & Wilcox Co, Beaver Falls, Penna.

Circle 45, Reader Service Card

VIBRATION PICKUP—Bulletin 1535D, 2 pp. Discusses applications and construction of miniature, self-generating, lightweight pickup. Gives specs. Includes vibration nomograph and dimensional diagrams. Consolidated Electrodynamics Corp, 300 N Sierra Madre Villa, Pasadena, Calif.

Circle 46, Reader Service Card

INDUSTRIAL CONTROL—Bulletin 958, 8 pp. Describes and illustrates individual products and assembled controllers. Introduces new line of speed-responsive switches. Euclid Electric & Mfg. Co, Madison, Ohio.

Circle 47, Reader Service Card

1958 MINIATURIZATION AWARD—Brochure. Outlines criteria, provides entry form and gives information on award, which will be presented for best example of miniaturization developed during 1958. Miniaturization Award Committee, Box 604, Keene, NH.

Circle 48, Reader Service Card

SHEATHED CABLE—Catalog, 16 pp. Describes construction and applications; gives engineering information and test results, typical diameters and ordering information. Simplex Wire & Cable Co, 79 Sidney St, Cambridge 39, Mass.

Circle 49, Reader Service Card

SOLENOID CONTROL VALVES—Catalog 2000, 12 pp. Presents ac and dc models of 2- and 3-way high-pressure solenoid valves for hydraulic power systems. Information includes dimensions, port sizes, weight, specifications, performance data and construction features. With pressure drop charts. Waterman Engineering Co, 725 Custer Ave, Evanston, Ill.

Circle 50, Reader Service Card

SPEED REDUCERS—Bulletin 20B9053, 4 pp. Discusses construction and operating features and identifies components of shaft-mounted speed reducers for direct mounting on driven shaft. Allis-Chalmers Mfg Co, Milwaukee 1.

Circle 51, Reader Service Card

SNAP-ACTION CAM SWITCH—Bulletin, 4 pp. Suggested cam rise angle, type of actuators, possible variations and other technical engineering information. Cherry Electrical Products Corp, 1650 Deerfield Rd, Highland Park, Ill.

Circle 52, Reader Service Card

SCREW PUMPS—Bulletin SI-6, 6 pp. Outlines construction, operating characteristics, dimensions and capacities. Sier-Bath Gear & Pump Co, Inc, 9252 Hudson Blvd, N. Bergen, NJ.

Circle 53, Reader Service Card

THERMOSETTING PHENOLIC MATERIALS—Brochure, 12 pp. Illustrates applications and presents range of properties in chart form. Plastics Engineering Co, Sheboygan, Wis.

Circle 54, Reader Service Card

PLASTIC FILMS AND FOAM SHEETINGS—Data folder, 7 pp. General, mechanical, thermal, chemical properties are given, as well as performance data. Samples are included. Ludlow Papers Inc, Needham Heights 94, Mass.

Circle 55, Reader Service Card

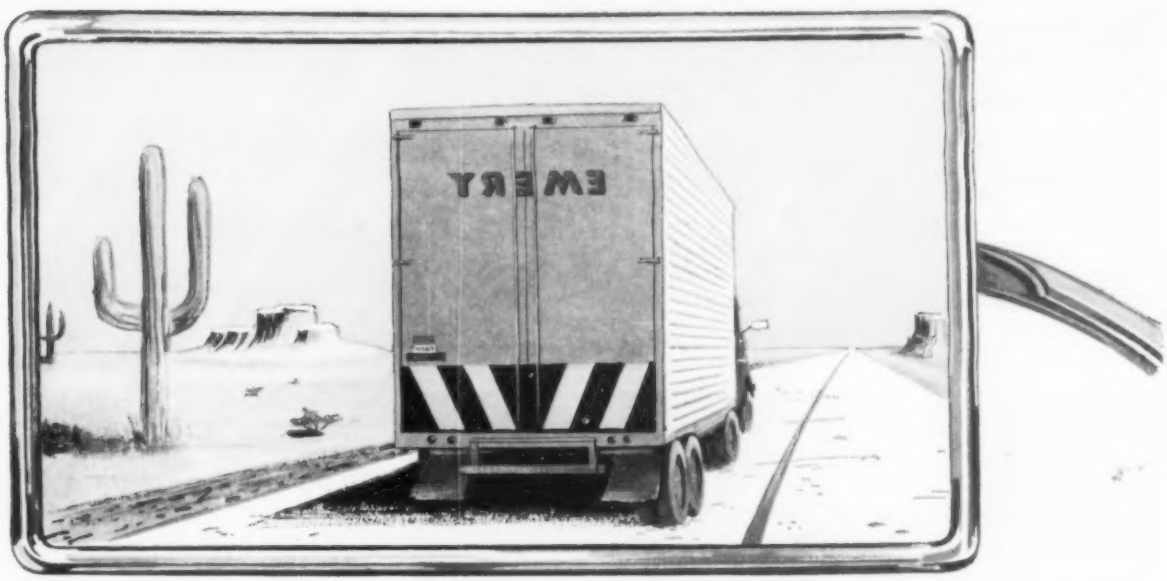
Letterhead Requests Only

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

SQUARE-FOOT CONVERTER—Pocket-size booklet, 12 pp. Sq ft conversions for plastic sheets up to 67 x 102 in., decimal equivalents involved and sheet, rod, tube diameters and thicknesses. Commercial Plastics & Supply Corp, 630 Broadway, New York 12.

TIME ZONE MAP—Printed in three colors on 8½ x 11 in. card. Shows standard time zones of US and Canada. May be displayed on wall or desktop. Ohio Seamless Tube Div, Copperweld Steel Co, Shelby, Ohio.

RIGID URETHANE FOAM INSULATION
passes rugged "road test"!



In use under actual road conditions, rigid urethane foam insulation is rated excellent for all-around performance in refrigerated truck trailers!

It is currently proving its superiority as well in "reefer" cars, home appliances, and industrial, commercial and other refrigeration equipment.

Besides combining insulating efficiency with many practical plus values, urethane frequently costs less installed. Molded, sprayed or foamed in place or worked from slab stock, urethane foam saves production time and labor. Since it adds rigidity, lighter structural materials can be substituted in many applications

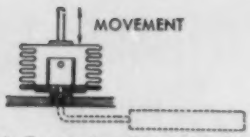
If you want to explore the use of urethane foam insulation, our application laboratory can give you valuable assistance. We produce NACCONATE® Diisocyanates, essential components in all urethane formulations.

Modular "sandwich" panels of rigid urethane foam, provide complete isolation for truck trailers, eliminating heat loss due to through-metal contacts.

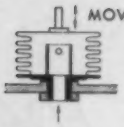
Lightweight urethane retains its high efficiency longer. It has low moisture pick-up, doesn't "pack down" and withstands 250°F. without deterioration. Modular construction facilitates repair and replacement.

NATIONAL ANILINE DIVISION
40 RECTOR STREET, NEW YORK 6, N. Y.
Atlanta Boston Charlotte Chattanooga Chicago Greensboro
Los Angeles Philadelphia Portland, Ore. Providence San Francisco

Allied Chemical



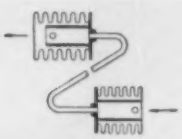
Regulate Temperature Temperature changes cause a thermostatic charge in the bellows to expand and operate a valve, switch, damper, etc. Charge can also be in an external cup.



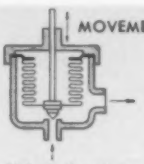
Control Movement Converts pressure effects inside the bellows into controlled movement. Another assembly accomplishes the same job with pressure applied within an external cup.

Absorb Expansion Thermal or pressure expansion is absorbed by this assembly. With suitable heads, it can serve as a liquid or gas reservoir, such as an oil reservoir for an electrical cable joint.

Absorb Vibration, Expansion Used as packless, leakless expansion joints to absorb thermal expansion of steam and water lines, and to absorb vibration or provide flexible connections in other applications.

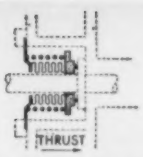


Transmit Motion Thermostatic or mechanical motive force is applied to two Sylphon® bellows assemblies joined by a tube for hydraulic transmission of motion or power.

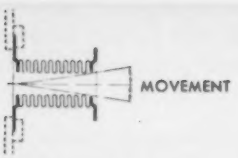


Seal Packless Valves Seamless metal Sylphon® bellows replace packing to form leakproof valves that never need re-packing. Also used to seal stem movement or adjustment.

Cost-Saving
IDEA STARTERS
with
SEAMLESS METAL SYLPHON® BELLOWS



Seal Shafts Spring pressure holds nose of seal against shoulder on shaft. Used for refrigerator compressors, etc., to prevent leakage around revolving shaft. Another type rotates with shaft and seals against stationary plate.



Seal Flexible Joints Used to seal a flexible joint or mechanical movement of levers, linkage, etc., against leakage where the movement must be conveyed outside an enclosure, such as operating stem of float switches.

Fulton Sylphon Bellows Assemblies

Does one of these bellows applications spark an idea for improved design or cost reduction for your product? Your application idea combined with our half-century of experience in making custom-engineered bellows assemblies may lead to tangible benefits for your company. Write for Engineering Service or Catalog XP-1400.

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tennessee

DESIGN ABSTRACTS

Viscosity-temperature Characteristics

Viscosity index method for indicating change of viscosity in a lubricant with temperature has several disadvantages. A system which covers entire viscosity range of all liquids and temperature range of −100 F to 700 F is described. Termed a slope index, it is based on ASTM viscosity-temperature chart and the Walter equation, published in 1932; adopted 1939.

"Slope Index—An Expression for Viscosity-temperature Characteristics," Klaus, Hersh, Pohorilla; Lubrication Engineering, Oct. '58, 84 E Randolph St, Chicago 1.

Fastenings

A survey (in German) of types of fastenings is presented and a simple system for relating virtually all types and classes is developed.

"Survey of Fastenings," W Bischoff, Technical Univ of Ilmenav (E Germany), Feingeratelechnik, Sep '58, 12 Unter den Linden, NW 7, W Berlin, Federal Republic of Germany.

Designing the Experiment

A procedure for determining in advance the degree of decision ability inherent in a proposed experiment and ascertaining capacity to measure effects requiring evaluation is described. Sample risk curve, test pattern selection chart, and test sequence are included.

"Designing the Experiment," W J Hill, Ford Instrument Co, Engineering Log, 31-10 Thomson Ave, Long Island City 1, NY

Inventions and Patterns

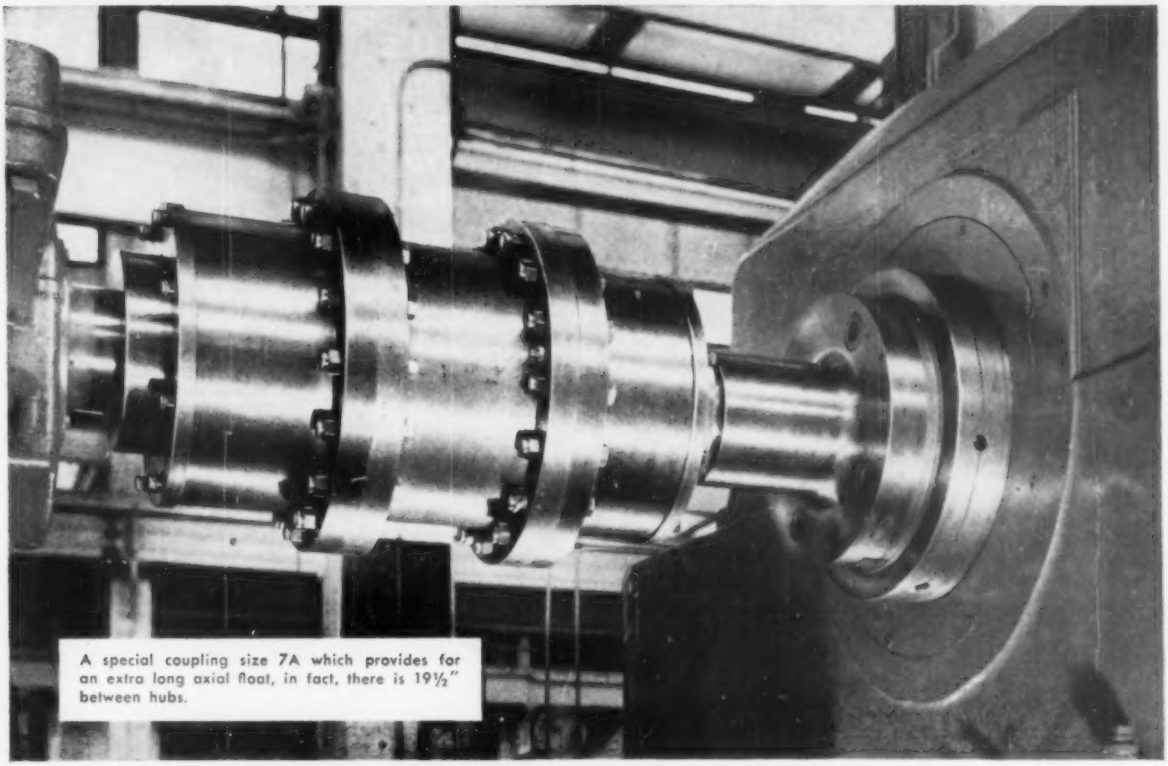
A panel consisting of K. J. Germeshausen (Edgerton, Germeshausen & Grier Inc), P. K. McElroy (General Radio Co), and R. H. Rines (Rines and Rines) and representing, respectively, the inventor's, the commercial and legal points of view discussed questions of concern to the practicing engineer at Northeast Electronics Meeting, Nov 19-20. (Write IRE, 1 E 79th St, New York 21).

Ductile Vanadium

Sources of ores, extraction, reduction and refining methods, fabrication, availability, properties are discussed.

"Ductile Vanadium—A New Engineering Material," T W Merrill, Vanadium Corp of America, Manufacturing Chemists Assn, 1625 Eye St, NW, Washington 6, DC

SPECIAL COUPLING PROBLEMS



A special coupling size 7A which provides for an extra long axial float, in fact, there is 19½" between hubs.

SOLVED

at JOHN WALDRON

From time to time, manufacturers are faced with special power transmission problems which cannot be handled by standard couplings. Sometimes they need a coupling for exceedingly high speed drives, sometimes a coupling for very large diameter shafts and for other special applications.

John Waldron, which is well known for its ability to produce high quality couplings also makes excellent special couplings to customer requirements. In the past, Waldron has made couplings that turn at speeds over 50,000 RPM, couplings which can take over 45,000 HP and couplings for particular applications such as continuous lubricated couplings, spacer types, shear pins, cut-outs and couplings for many other special installations.

If you have a particular power transmission problem that needs a special coupling, call or write the John Waldron Corporation in New Brunswick, New Jersey. Their long experience in designing, and manufacturing couplings for special problems, may have already solved your problem for you.

M-R

JOHN **WALDRON** CORP.

Subsidiary of Midland-Ross Corporation

New Brunswick, New Jersey

"JABSCO PUMPS have proven superior to any others we have tried"...

...FELKER MANUFACTURING COMPANY

Jabsco self-priming pumps are tops for high performance and complete dependability, and there's a Jabsco *specifically* designed for your requirements. Mr. F. K. Ryan of Felker Manufacturing Company, world's largest manufacturer of diamond abrasive cut-off blades and machinery, reports that "The pumps used on our concrete saws must accommodate large amounts of foreign matter and impurities, as well as withstand rough field usage"—a difficult pumping problem, and Jabsco pumps proved to be the most profitable solution.

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Bronze, stainless steel, plastic, and cast iron in plain or ball-bearing models.

- Self-priming!
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- Easy maintenance—self lubricating!
- Dependable—neoprene impeller is the only moving part!
- Advanced design—reversible wear plates!
- High capacity!

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Company_____
Street_____
City_____ Zone____ State_____

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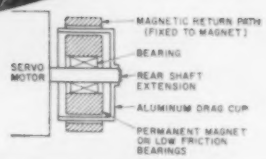
EAD's Inertially Damped Servo Motors

One compact unit—EAD's high performance servomotor and an inertial damper. Electrically equivalent to a lead-lag network. This damper means: maximum velocity constants; excellent damping; line frequency insensitivity; no wiring or pick-up problems; suppression of residual noise; non-critical adjustments and no loss in shaft output. Meets significant military specs. Operates to 150° C. Supplied in sizes 10 and 15 as well.

Also available—Viscous Damped Servomotors. Write for complete data.



TYPICAL PARAMETERS Model No. SD1HLX7-2CC	
Size	BU ORD Size 11
Frequency	400 cps
Motor Power	3.5 watts/phase
Stall Torque	0.63 oz. in.
No Load Speed	6300 rpm
Magnet Damping	100 dyne-cm-sec.
Corner Freq., cps	f_1=0.3, f_2=1.6, f_3=16

EAD Eastern Air Devices, inc.
381 CENTRAL AVENUE
DOVER, NEW HAMPSHIRE

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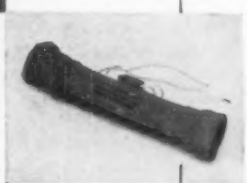
HEATING ELEMENTS

ELECTRO-FLEX *solves another difficult heating problem.*

THIS TIME FOR...



This quantity production element heats a resistoflex couple which is a flexible line 1¼" in dia., made of braided steel wire with hex fittings at each end. Line must be heated because it transmits liquid at very low temperature. Unit embodies snap-action thermostat sensing tubing temperature to hold 70 to 100° F.

If you have a special heating problem let us solve it for you. We are specialists in light-weight, tough, flexible elements of any shape or size. Units may be designed to operate under high pneumatic pressure. Insulation may be Silicone Rubber or Neoprene. Elements may be immersable or resistant to corrosion. All units meet USAF specifications.

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Material: Silicone rubber sponge, flexible enough to bend with the tubing.
Rating: 200 watts at 115 V. (1250 V. breakdown)
Resistance Tolerance: ±5%

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NEW BOOKS

Switching Circuits with Computer Applications

WATTS S HUMPHREY, JR. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9, 264 pp. $8.50.

The book mainly covers digital systems—a very common application of switching circuits. The methods described simplify the design of computers. It shows how very large systems can be designed without drawing a single circuit diagram. The resulting equations can then be converted directly to logical or simplified schematic form.

The first two chapters explain the binary numbering system and give the basic concepts of Boolean algebra. The remaining chapters cover relay contact networks, probability, coding systems, circuit logic, cascaded networks, sequential circuits and so forth. Emphasis is placed on developing circuits with the fewest number of components. Enough mathematical derivations are included to bridge the gap from college undergraduate math to the concepts in this text.

Introduction to Nonlinear Analysis

W J CUNNINGHAM, Professor of Electrical Engineering, Yale University. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 9 x 6, 349 pp. $9.50.

Methods for solving nonlinear differential equations with a single independent variable are included. Methods considered are those that can be applied with only modest facilities. Numerical, graphical and analytical methods are described, and many examples of physical systems illustrate both techniques of solution and unusual types of phenomena which may arise. A basic knowledge of electrical circuits, mechanical systems and linear differential equations is presumed.

Dispersed Hard Particle Strengthening of Metals

NICHOLAS J GRANT, OLIVER PRESTON. Available from Office of Technical Services, Washington, DC. 31 pp, 8½ x 11. $1.

A review is presented of the various methods of strengthening metals and

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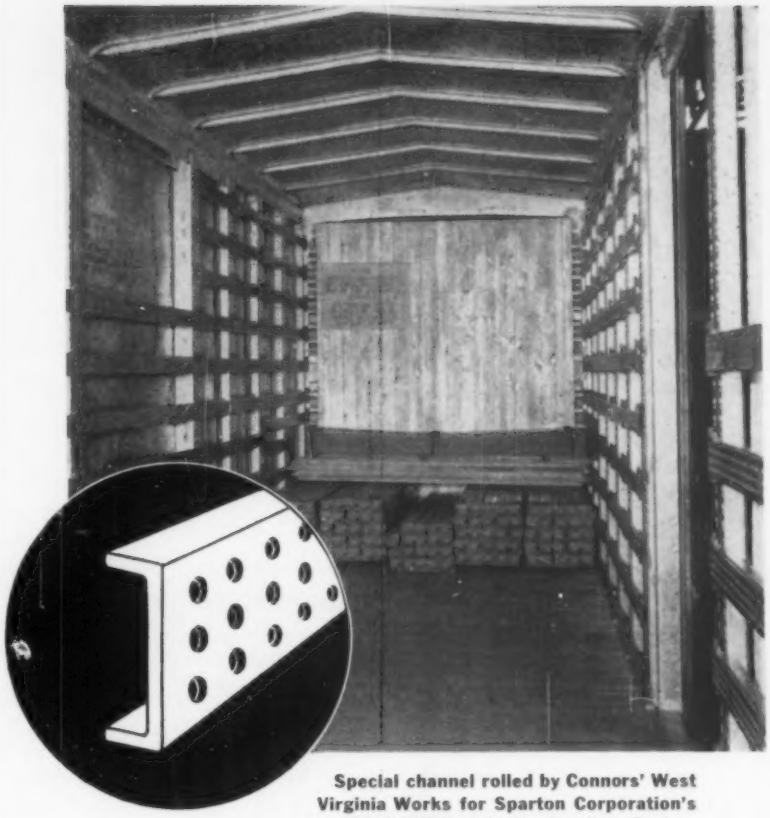

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alloys for high temperature service by a suitable dispersion of finely divided hard particles. Alloys such as sintered aluminum powders, molybdenum containing small quantities of refractory oxides and magnesium containing a dispersed intermetallic are considered. Internal oxidation and other methods of achieving a hard particle dispersion are discussed. New data on the high temperature strength and stability of the alloy systems Cu-Al_2O_3, Ni-Al_2O_3, and Be-Be_2C are shown. The theoretical aspects of the hardening and strengthening mechanism are presented and consideration is given to the problems associated with the powder metallurgy to the various processes.

Standard of the Expansion Joint Manufacturers Assn

Compiled by Technical Committee of EJMA, 53 Park Pl, New York 7. 8½ x 11, 32 pp. $1.

Expansion control in pipe lines which carry hot or cold fluids is a serious problem confronting the piping engineer. As temperature changes occur in the pipe lines, allowances must be made for changes in pipe length owing to thermal expansion. This publication sets forth recommended design standards for various types of metallic packless expansion joints for ducts, pipe lines, vessels and other similar applications.

Effects of Clothing On Tolerance to Heat

VEGHTE and WEBB, *Aero Medical Laboratory. (PB 131705) Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8¼ x 10¾, 10 pp. 50¢.*

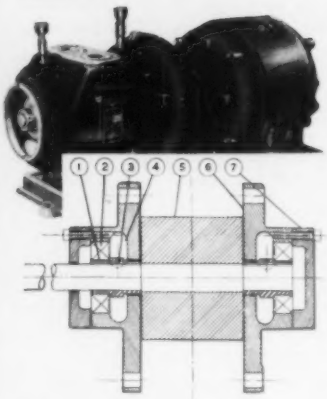
A series of experiments has been conducted to determine the effect of clothing on human tolerance to hot environments (90 to 160 F.) Exposures were made in five different clothing assemblies which were representative of permeable and impermeable, lightweight and heavily insulated Air Force clothing.

The effect of the exposures was measured in terms of physiological strain. These experiments show to what extent impermeable clothing as compared with premeable clothing, reduces human tolerance to heat, regardless of insulation value. Insulation alone serves a protective function in heat. However, a heavy permeable

(Continued on page 93)

KRAISSL AIR PUMPS

prevent vapor contamination with reliable oil-free lubrication



Objectionable oil vapor contamination of discharge air is eliminated by the graphite composition displacement blades—which furnish their own lubrication and take up their own wear.

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3. Keyed ball bearing and sleeve assembly permits easy removal of entire end plate assembly due to slide fit on shaft.
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7. New bearing cover design permits easy access for inspection and lubrication without pump disassembly.

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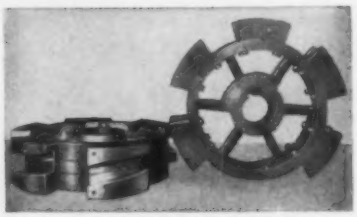
You incur no obligation in asking for assistance on your requirements. Send for illustrated literature . . . consult Rowbottom . . . NOW!!



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...Ready-to-go in your product

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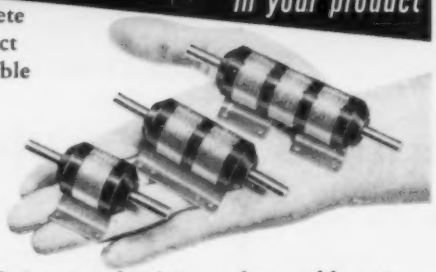

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assembly, by addition of several permeable layers, proved to be functionally impermeable.

Handbook of Electrical Discharge Machining

Elox Corp of Michigan, 1830 N Stephenson Highway, Royal Oak 3, Mich. In six sections, 8¾ x 11½. $25 per set.

The handbook is divided into six sections. Individual titles include: I—Applications for Industry; II—Equipment and Accessories; III—Theory and Application; IV—Operation and Maintenance; V—Service and Spare Parts; VI—Salvage Equipment.

Man-Machine Dynamics

ELY, BOWEN and ORLANSKY, *Dunlap Assoc, for Wright Air Development Center. Chapter VII of Joint Services Human Engineering Guide to Equipment Design. (PB 131576) Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8¼ x 10¾, 119 pp. $3.*

This report identifies and discusses factors affecting human performance in tracking and in watchkeeping (vigilance) tasks, and makes recommendations toward improving the performance of such systems. Whenever these recommendations are the direct outgrowth of published research, appropriate studies are cited. Other recommendations have been developed by the authors' own experiences.

The report is divided into three main parts: general information, important design factors in closed-loop systems, human time lags. A table of contents and an index are provided.

A Study of Muscle Forces and Fatigue

PAUL A HUNSICKER, *University of Michigan. (PB 131722) Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8¼ x 10¾, 47 pp. $1.50.*

The first phase of the research deals with results of 120 strength tests on 30 subjects. Subjects were seated in a simulated pilot-seat and six movements were tested. The results are presented in percentile tables and graphic form. The next part of the study involves data on 25 subjects who were tested to determine the amount of strength possible in wrist pronation and wrist supination. The final phase of the research gives information on the strength-decrement over a 42-hr period. Several recommendations are offered.

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They are also adaptable for high temperatures up to 600° F. equipped with fan, lantern and non-friction grease seal for fumes, etc.

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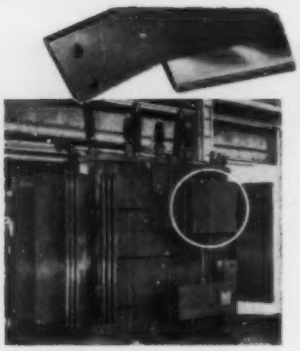
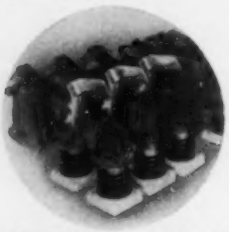
- MOLTEN METAL PUMPS



Transformer with Load Tap Changer equipment on side



Load Transfer Switch, showing Gibsiloy contact fingers

Gibsiloy ELECTRICAL CONTACTS CONTACTS

reduce costs, cut maintenance, resist sticking & erosion on Pennsylvania Load Tap Changer

Costs and maintenance have been cut on a Pennsylvania Transformer with load tap changing equipment. One good reason: Installing Gibsiloy UW-4 copper-tungsten electrical contacts.

Pennsylvania Transformer Division, McGraw-Edison Co., also finds Gibson contacts resist arc erosion and sticking, have good conductivity and long life. This means reduced operation cost for utilities buying the transformer with LTC to maintain automatic voltage level.

The same Gibson experience developing Gibsiloy UW-4 contacts approved by Pennsylvania Transformer can solve *your* contact problems. Send for complete technical data on Gibsiloy silver, tungsten, copper, nickel, palladium and other electrical contacts. Contact Gibson first on your next problem.

See our catalog in Sweet's Product Design File or write for Gibson Catalog C-520

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Manufactured by

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Current Reprints

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Gear Standards
Proposed all-inclusive standard for spur and helical, for both instrument and power service. Dec 22, '58 *Circle E 56*

Foreign Patents
Why get them? Six steps to follow for profitable licensing. Dec 15, '58 *Circle E 55*

Tired Metal
Why have fatigue problems when you can do without them? Six solutions. Dec 1, '58 *Circle E 54*

Linkage Joints
Discussion of motions and factors leading to better joints. Dec 8, '58 *Circle E 53*

Swivel Joints
These basics will reduce trial-and-error in design. Dec 8, '58 *Circle E 52*

Porcelain Enamel
New look at wide selection of colors and textured surfaces available. Chart describes enameling processes. Nov 24, '58 *Circle E 51*

Relays
Money-saving guide and 17 questions that help avoid overdesign. Nov 24, '58 *Circle E 50*

Tap the Reserve Strength in Metal
Charts and formulas for determining how far beyond the yield strength you dare go. Sep 29, '58 *Circle E 49*

Springs that Store Energy Best
How shape and material govern efficiency; table compares 13 spring shapes. Nov 10, '58 *Circle E 48*

Which Tachometer?
Selection chart matches each available method to the need. Nov 10, '58 *Circle E 47*

Microfilm
How miniaturization of records can solve administrative problems and save design time. Oct 27, '58 *Circle E 46*

Numerical Control of Machine Tools
How it works; where it's heading; covers both discrete and continuous path. Oct 27, '58 *Circle E 45*

Optical Projectors
How projectors may be used in development, research and laboratory testing. Chart gives limitation and advantages of 30 conditions. Mid-Sep '58 *Circle E 44*

Three New Rigid Thermoplastics
Delrin, Lexan and Pro-fax are compared; curves and tables. Sep 29, '58 *Circle E 43*

Electroluminescence
New area-source of light which needs no filament, arcing or activating rays. Sep 15, '58 *Circle E 41*

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✻ **FOUR group reprints with reference data on current problems in product design are now available for immediate delivery.**

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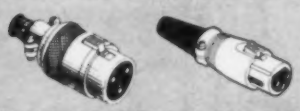

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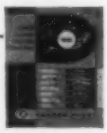

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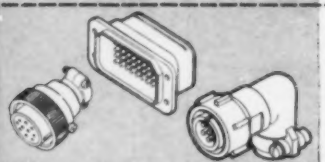

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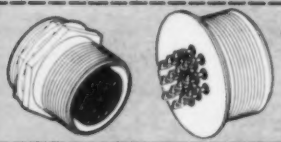

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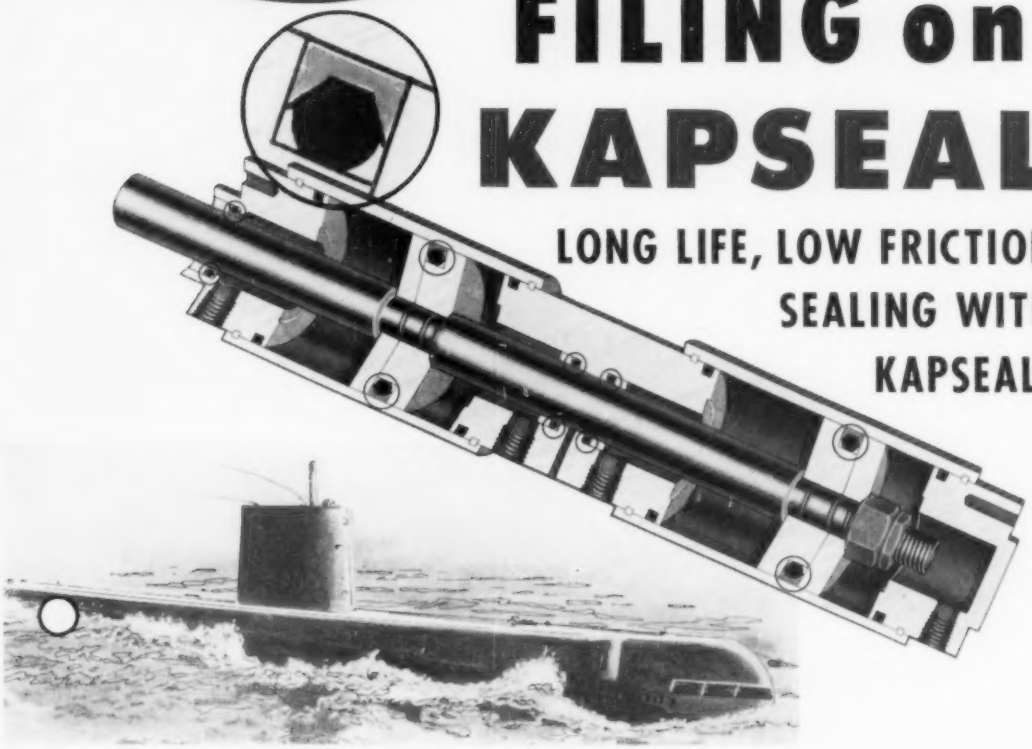

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COMBINES WITH A STANDARD O-RING

The KAPSEAL comes in two styles, KIN and KEX. KIN is used when the ID of the seal is the sealing surface, while KEX is used when the OD is the sealing surface. The KAPSEAL combines with a standard O-ring and the combination can be installed in any gland that was designed for the O-ring only. The combination can also be used to replace stacks of V-rings giving a greatly simplified design. A "buttoned-up" design is possible because the long-life, low-friction characteristics of the KAPSEAL reduce seal replacement requirements to the extent that the mechanism can be sealed shut.

WHERE LIFE OR FRICTION IS A PROBLEM, THE KAPSEAL IS THE ANSWER

KAPSEAL is a trademark of Minnesota Rubber Co.
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FOR MORE INFORMATION ON THE KAPSEAL . . .

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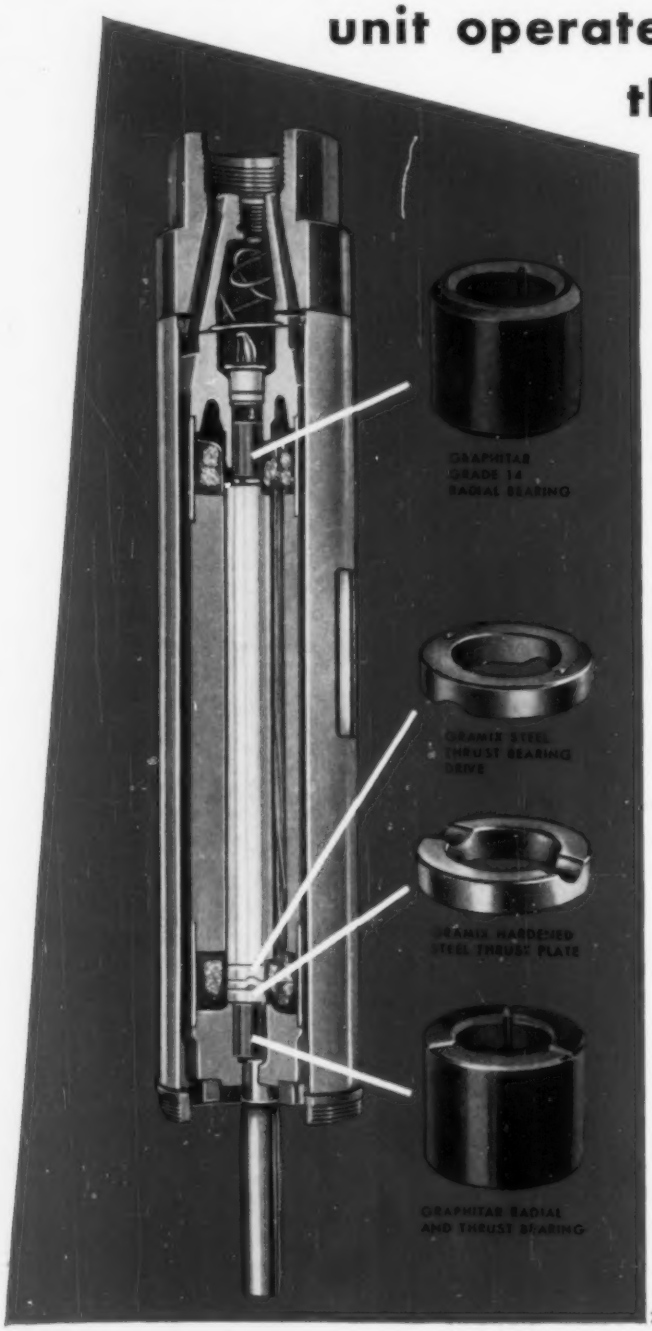
bearings in Leland submersible motor unit operate with gasoline as the only lubricant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Running directly in gasoline, this superbly-designed Leland submersible motor embodies two GRAMIX thrust washers and two GRAPHITAR bearings to keep the operation of this amazing explosion-proof pump motor safe and smooth.

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